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THE UNIVERSITY OF KANSAS
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# A Macroscopic and Microscopic Study of the Mental Hedonic Gland-clusters of Some Plethodontid Salamanders

By G. THOMAS TRUFFELLI

ABSTRACT. The mental hedonic gland-cluster is a small patch of glands located near the tip of the chin of most, if not all, male plethodontid salamanders. The structural relationships of the gland-clusters of several species of Mexican and South American plethodonts were investigated. Both macroscopic and microscopic morphology are discussed. Reference is made to the origin and function of the glands.

Structural characteristics indicate that the gland-clusters present in the genus *Oedipina* are the most specialized, while the clusters found in the genera *Pseudoeurycea, Chiropterotriton, Bolitoglossa, Magnadigita* and *Thorius* display lesser degrees of specialization.

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## INTRODUCTION

A small cluster or patch of glands is found on or near the tip of the chin of most, if not all, species of plethodontoid salamanders. This cluster is usually evident as a small oval, circular, cordiform, or somewhat triangular structure, slightly elevated and generally differing in color from that of the surrounding skin. This cluster of glands, which occurs only in males, is obviously a secondary sexual character, since previous studies have shown that the glands function during the breeding season in some manner so as to stimulate the female into activity during courtship. These glands have been referred to by certain authors as hedonic glands, but since this name has been utilized in a general way, the patch of glands is here designated as the mental hedonic gland-cluster.

The character of this cluster of glands has been ascertained in many of the North American plethodontoid genera, but only a most superficial examination of it has been made in those genera occurring in Mexico and Central America. The purpose of this paper, therefore, is to describe the glands in several genera of Mexican and South American plethodontoid salamanders, and also to interpret any evidence of relationships among the genera and species examined as indicated by the cluster.

## METHODS AND TECHNIQUES

Two methods were used in this investigation to achieve the desired results. The following is a description of these methods.

*Macroscopic.* The cluster of glands which is embedded in the skin immediately posterior to the symphysis of the mentomeckelian bones at the anterior angle of the lower jaw was exposed by cutting the skin loose from the bone and pulling the skin backward from the snout. This exposed the cluster so that it could be studied *in situ* or removed for sectioning. Several attempts were made to stain the glands *in toto,* but some difficulty was encountered, so that this procedure was abandoned and unstained whole mounts were substituted. For observation, the skin flap containing the cluster of glands was pulled to one side and examined over a dark background with a binocular dissecting microscope. Using this technique it was possible to determine the number of glands, their shape and approximate size, and their arrangement within the cluster. Relatively accurate measurements of the entire cluster were also possible. The cluster was either placed directly over a rule, or was measured with calipers. It is possible that there was a slight error in counting

the number of glands in each cluster, because in many instances they were irregular in size and shape, and there was some overlapping of the individual glands. The measurements of thickness of any cluster includes the limiting membrane of connective tissue as the internal border and the epidermis as the external border. The epidermis is included in these measurements because microscopic examination revealed that the external pores were at the external surface of the epidermis.

*Microscopic.* Microscopic studies were made of the clusters of several species. Only mature males were used. All the specimens used in this investigation had been killed and preserved for museum study several years previous to this investigation, and as a consequence the degree of fixation was not constant throughout the series. All the specimens had been preserved in formalin and transferred to 70 per cent alcohol.

A skin flap containing the cluster of glands was obtained in the same manner as for the macroscopic examination, except that for microscopic studies the cluster was removed. Usually a portion of the skin surrounding the cluster was left attached to the cluster so that comparisons could be made between the hedonic glands and the mucous glands located throughout the skin. The clusters were then placed in fresh 70 per cent alcohol, run in consecutive steps up to 100 per cent alcohol, and transferred into zylene. From the zylene they were transferred to mixtures of zylene and paraffin and then into pure paraffin. They were embedded in pure paraffin and placed in a refrigerator to harden. Sections were cut at 6-8 microns, transferred to microscope slides, attached with egg albumen, and allowed to dry for 24-48 hours before staining.

Several stains were used experimentally but the stain found to produce the best resuts was Mallory's Triple stain (1921, p. 219). The technique used in staining is that prescribed by Guyer (1921, p. 219).

## ACKNOWLEDGMENTS

I wish to thank Dr. Edward H. Taylor, under whose direction this study was pursued, for the use of his large collection of plethodontid salamanders, many of which are discussed in this paper, and also for the time and energy he has expended in helping with the preparation of this paper. I wish to also thank Dr. A. Byron Leonard for his kind assistance in describing some of the microscopic structures found in this investigation.

## PREVIOUS INVESTIGATION OF STRUCTURE AND FUNCTION OF THE GLANDS

Most of the experimental work pertaining to the hedonic glands has been concerned with function rather than with structural relationships; however, such work as has been done on the structure has been excellently recorded by several authors.

Noble (1921, p. 4), describes the hedonic glands of *Eurycea bislineata* as having a central lumen bordered by tall columnar cells, with a finely granular or pasty cytoplasm. The cells stain bluish-purple in Mallory's stain and pink in hemotoxylin.

Smith (1941, p. 259), in describing the hedonic glands of *Triturus torosus* states that during the height of development the gland may contain several types of cells, and that they are chiefly columnar, with elliptical nuclei so oriented that the long axis is parallel to that of the cell, and that although a few of the nuclei appear pyknotic, most of them stain similarly to those of the surface epithelium. Smith further states that the cytoplasm contains small basophilic and a few refractile granules, and at the height of development the central part of the hedonic gland is crowded with cells. He believes that the gland is of the holocrine type, because the granular epithelium is usually destroyed during the elaboration and expulsion of the glandular product. He states also that the glands are surrounded by what is apparently a myo-epithelial capsule which may be instrumental in the discharge.

Noble (1929, p. 4), in describing the hedonic glands of *Eurycea bislineata,* states that the gland on the dorsum of the base of the tail is large, but is not visible externally in the living animal. The glands on the sides of the body and on the legs are also generally invisible externally in the living animal. The glands on the eyelids and in the temporal region have also been shown to be hedonic glands. Noble (1929, p. 4) states also that microscopic sections of the female of the same species showed no evidence of hedonic glandular tissue anywhere on the head, body, or tail.

"Hedonic glands of the type found in *E. bislineata,*" continues Noble (1929, p. 4), "are of general occurrence in the *Plethodontidae,* and homologous structures seem to occur in *Salamandridae.* They appear as visible structures on the lower eyelids of the male *Desmognathus f. fuscus* and *D. f. carolinensis.* They form a small but distinct dorsal protuberance at the base of the tail of the male *Eurycea multiplicata.* This glandular mass develops even in the male larva of the latter species before metamorphosis and is prob-

ably homologous with the less glandular tail-spine of *Salamandra caucasica.* The enlarged glands scattered over the head and body of the male *Typhlomolge* have been found to be hedonic glands. Usually the hedonic glands are not visible for the hypertrophied mass which forms the mental gland." Noble (1929, p. 4), states that he has found hedonic glands in male *Desmognathus phoca, D. f. fuscus, D. f. carolinensis, Leurognathus m. intermedia, Plethodon cinerus, P. jordani, Hydromantes italicus,* as well as in the species already mentioned. "Only in *Aneides lugubris* and *A. aeneus,*" states Noble (1929, p. 5), "have apparently homologous glands been found in both sexes. These glands are widely spread over the lower sides of the body and ventral surfaces of both sexes and are readily visible in the living animal as yellowish spots."

All evidence to date seems to indicate that the hedonic glands are a secondary sexual character, and that actually the glands function only just before and during the breeding season. According to Noble (1931, p. 137), the secretions of the hedonic glands of newts and plethodontid salamanders have no recognizable odor to man and yet they seem to function in holding the attention of the female during courtship.

## ORIGIN AND GENERAL CHARACTERISTICS OF THE HEDONIC GLAND-CLUSTER

As to the origin of the hedonic glands, Noble believes that they have apparently arisen from the mucous glands during phylogeny, and have developed into another type of gland of totally different function. "The male *Plethodontidae,*" according to Noble (1931, p. 136), "develops glands having a slightly granular secretion which apparently serves to attract the female. A patch of these glands on the chin usually becomes enlarged to form a conspicuous pad."

It is not difficult to believe that the hedonic glands have arisen from the mucous glands which are found throughout the skin of the salamander, because of their close similarity in structure. There is, however, enough difference in the structure of the two types of glands to distinguish one from the other. In general, the cluster of mental hedonic glands consists of a mass of glands, each lined with secretory cells which produce a finely granular secretion. The individual glands are enveloped in a thin connective tissue membrane or network, while the cluster is limited internally by a relatively thicker layer of connective tissue, the limiting connective tissue membrane (hereafter referred to as the *limiting membrane*),

which appears to contain a few muscle cells. The cluster is limited externally by the epidermis, and the necks of the glands through which the secretions flow, are found protruding into the epidermis and open at its external surface.

There is no apparent physical mechanism which causes the secretions of the glands to flow. Probably, however, the glands of the plethodontoid salamanders are of the holocrine type, as Smith (1941, p. 259), has described them in *Triturus torosus,* and that during the breeding season, especially during courtship, the secretory cells burst or disintegrate when external pressure is applied to the glands and this causes the secretions to flow. Microscopic examination indicates that the few muscle cells present in the limiting membrane would be insufficient to force the secretions from the glands.

The mental hedonic glands show little or no microscopic variation throughout the family *Plethodontidae.* In general, the glands seem to be simply constructed, with the individual glands standing perpendicular to the epidermis, with their external pore openings at its surface. The secretory cells which are generally of the columnar type are arranged perpendicular to the walls of the glands. The nuclei of the secretory cells are elliptical to globular in shape, and when elliptical are found with their long axes parallel to that of the cells.

Macroscopic examination of the clusters of glands, however, shows some degree of variation in the different genera and species examined. These variations are evident as differences in size and shape of the clusters, the number of glands and their arrangement, and the presence or absence of pigmentation in the limiting membrane.

## SEASONAL VARIATION

In general, the clusters of glands examined displayed a large degree of uniformity in development regardless of the time of year when the specimens were taken. In one species, however, a marked degree of seasonal variation was found in the cluster. Several specimens of *Bolitoglossa platydactyla* taken at Cuautlapan, Veracruz, in January, 1939, showed little or no evidence, either macroscopically or microscopically, of glands differing from the surrounding mucous glands. But specimens taken from the same location in July, 1940, displayed a prominent cluster of mental hedonic glands. One of the specimens taken in January was sectioned and the area in which the glands normally appear was covered with glands differing in no apparent manner from the mucous glands found in the rest of the

dermis of the salamander. Only a few of the specimens taken in January showed any evidence of differentiated hedonic glandular tissue. The undeveloped glands were short, and somewhat mushroom-shaped. Externally there was no elevation marking the presence of the cluster, but there was a slight differential coloration marking its location. This species of salamander was the only one that showed seasonal variation, but Smith (1941, p. 259), mentions that in *Triturus torosus,* "the greatest development of the hedonic glands is exhibited by *torosus* males in the height of breeding condition prior to amplexus." However, in the collection of Plethodontid salamanders studied, by far the largest part was collected in the months of June, July, August and September.

## GENERIC AND SPECIFIC CHARACTERISTICS OF THE GLANDS AND GLAND-CLUSTERS

### GENUS PSEUDOEURYCEA Taylor

The mental hedonic gland-clusters vary in size and shape in this genus. They are circular in *Pseudoeurycea c. cephalica* and *P. belli;* broadly oval in *P. c. rubrimembris;* and they are almost triangular in *P. leprosa* and *P. gadovii.* In all the species examined the gland-clusters are composed of many glands which are generally not uniform in size and shape, *P. belli* being exceptional in having glands of relatively uniform diameter. The limiting membrane marking the dorsal boundary of the cluster is of approximately the same thickness as that found in the other genera. The granules of dark pigment found in this membrane, scattered at random between the bases of the glands, are missing only in *P. gadovii.*

In microscopic section the glands seem to be long and cylindrical, the dorsal end (base) being closed, while the ventral end (apex) is narrowed to a small tube, which terminates at the surface of the epidermis in a small external pore. The glands are all distinctly separated from each other by a thin layer of connective tissue, which envelops each of them, but they are, in general, closely approximated. The glands contain cells of the tall columnar type, containing a finely-granular cytoplasm, and a nucleus varying from globular to elliptical in shape. The bases of the cells rest upon the wall of the glands, and the long axes of the cells are perpendicular to the long axes of the glands. The nuclei are situated near the bases of the cells and when they are elliptical their long axes are parallel to that of the cells. There is a lumen present in the central part of the glands where the secretions from the cells presumably are collected before being ejected.

The regions between the narrowed necks of the glands contains small vacuoles of fat, masses of connective tissue, or small blood vessels. The limiting membrane, which marks the dorsal border of the cluster, is composed of short, thin fibers that cover the hedonic gland-cluster and extend away from it in all directions. The muscle cells are few in number, and are scattered throughout the walls of the glands, and occasionally in the limiting membrane. There is no distinct physical separation between the hedonic and mucous glands, but the differences in size and affinity for stain between these two types of glands are marked in the two species from which glands were sectioned.

In this genus the mental hedonic gland-clusters are easily recognized when the chin of the animal is observed. The cluster, in all species, is evident as an area lighter in color than that of the surrounding skin, and in this genus the cluster presents an elevation along its posterior and lateral borders in all the species examined except *P. gadovii* in which the elevation is most prominent in the center of the cluster. The gland-clusters in the species of this genus when intact, lie flat in a shallow cavity formed in the musculature of the lower jaw.

Microscopic sections of the gland-cluster of *P. leprosa* show that the individual glands are closely crowded together and that they are wrinkled and distorted. This wrinkling is probably the result of either degeneration or internal compression within the cluster. The thin envelope of connective tissue surrounding each gland is also wrinkled and this made identification of the individual glands somewhat difficult. Although the gland-cluster of only one specimen was sectioned, macroscopic examination of the clusters in numerous other specimens indicated that this wrinkled condition was common to all of them.

The glands of the cluster in *P. c. rubrimembris,* are irregular in diameter, some being six to eight times larger in diameter than others, while in the other species the glands are relatively uniform in diameter within each species.

The gland-clusters in this genus resemble some of those in the other genera examined. A description of the physical characteristics of the gland-clusters of the *Pseudoeurycea* are presented in Table I, and from this as well as the text and drawings resemblances between the clusters of the species of this genus and others can be seen. The macroscopic physical characters are sufficient for identification of each species examined.

There is no physical separation between the hedonic and mucous glands. The shape of the two types of glands and their individual affinities for stain are sufficient characters to differentiate them, as is seen in the drawings in Plate I (fig. 7).

### GENUS CHIROPTEROTRITON Taylor

The species of this genus are generally of medium size as compared to the other genera examined in this investigation. The shape of the hedonic gland-clusters in this genus varies greatly; some are subtriangular, some are subcircular, and others are ovoid. The gland-clusters are made up of a single layer of glands, limited internally by the limiting membrane which is uniformly thin throughout the genus. The glands are relatively large, and in general, are less numerous than in the other genera except *Thorius* and *Oedipina*. *Chiropterotriton lavae* is an exception having a large number of glands. The cells line the walls of the glands and the axes of the elliptical nuclei are parallel to those of the cells. The cells are mostly of the tall columnar type and stain similarly to those of the surrounding dermal layer. The glands are generally "cone-shaped," and are each distinctly enveloped in a membrane or network of connective tissue. In most species the glands seem to be separated from each other more than they are in the other genera, giving the cluster an appearance of being loosely constructed.

Any difficulty encountered in discerning externally the gland-clusters of the species in this genus is usually because they are so small, and the elevation produced by the presence of the cluster is easily overlooked; however, in all species there is some difference in the color of the epidermis covering the cluster from that of the surrounding area.

Microscopic sections of the gland-clusters of the species in this genus show essentially the same structure as that seen in the species of *Pseudoeurycea*. The same relationship is noted between the position of the cells and cell nuclei to the gland walls. The nuclei of the cells, when elliptical, are parallel to the axis of the cells, as in *Pseudoeurycea*.

The specimen of *C. chiroptera* selected for microscopic examination seems to have been taken in the breeding season, since the cells of the glands were greatly swollen and contained a heavy granular material. Some of the cells appeared so heavily laden with this material that their walls had either burst, or were destroyed in fixation, because the granular material had been released into the lumina of the glands. The cells, which were distinguishable in the sections,

had shifted their position and instead of being perpendicular to the axis of the glands appeared to be directed toward the external pores. The nuclei, which stain very deeply, lie almost flat against the wall of the gland, and also seemed to be directed toward the external pores. The granules in the cells and in the lumina of the glands stained a bright golden color with Mallory's triple stain.

The gland-clusters of several specimens of *C. dimidiata* examined exhibited a slight protuberance at the extreme posterior median border. This protuberance, as can be seen in Plate II, fig. 5, is caused by the considerable enlargement of a single gland which is about 1.5 times larger than any of the others in the cluster.

The gland-cluster of *C. arborea* exhibited a characteristic structure. Observation of the dorsal surface of the cluster showed a trilobate condition, being caused by an elongation of the glands in the median anterior-posterior region. The glands in the lateral regions, being shorter, accentuate this trilobate appearance of the cluster. The cavity in the musculature of the lower jaw presents a similar appearance, the median anterior and posterior part being markedly deeper than the lateral parts. Microscopic sections of this cluster show essentially the same structure as that seen in *C. chiroptera.* The sections of *C. arborea* also show greatly swollen glands containing a heavy granular material. The granules are the same bright golden color and are of the same approximate size as those seen in *C. chiroptera.* In the glands of *C. arborea,* however, the majority of the columnar cells have their long axes perpendicular to the walls of the glands, and the nuclei are globular rather than elliptical as in *C. chiroptera.*

The gland-clusters in this genus, as in the *Pseudoeurycea,* lie in a shallow cavity in the musculature of the lower jaw when intact. The physical characters of the clusters of the species of *Chiropterotriton* examined are presented in Table II.

### GENUS LINEOTRITON Tanner

One species of the genus *Lineotriton* (*L. lineola*) was available for investigation. A description of the physical characteristics is presented in Table III, and a drawing of the gland-cluster is found in Plate III, fig. 1. On the basis of this one species the cluster is seen to be similar in structure to those of the other genera except *Thorius* and *Oedipina.*

## GENUS BOLITOGLOSSA Duméril and Bibron

The species of the genus *Bolitoglossa* are considerably larger than those of the genera previously discussed. In general, the gland-clusters of this genus are subcircular to somewhat cordiform, with the apex directed anteriorly, and one species displays a curious asymmetry. The individual glands are small and numerous, and in all the species but *B. schmidti* they are distinctly separated from each other. They are, in general, uniform in size and number within a given species, but there is much contrast between different species, while the whole clusters may be of similar proportions. Also characteristic of the various species is the presence of numerous granules of dark pigment in the limiting membrane, scattered between the bases of the glands.

Microscopically the clusters appear to be constructed simply with the glands situated side by side, as may be seen in the drawing of a section of the cluster of *B. mexicana* (Plate III, fig. 9). The relationship between cell nuclei, cells, and glands is the same in this genus as in *Pseudoeurycea.* Microscopic sections, moreover, show that the structures of the clusters in this genus resemble those of the *Pseudoeurycea* in every respect except size.

The gland-cluster of *B. platydactyla* is characterized by a protuberance at its posterior median border. In all of the specimens studied of this species, the gland-cluster displayed a curious asymmetry, having one side rounded, and the other flattened. The drawing (Plate III, fig. 3) illustrates one of the more extreme examples of this asymmetry.

The gland-clusters of *B. rufescens* are also distinctively shaped. In the specimens examined they are somewhat cordiform, but the lateral borders in the anterior part of the cluster are concave. In all of the other species examined in this investigation the lateral borders are convex. Another characteristic of the cluster of this species is the arrangement of the dark granules of pigment found in the limiting membrane. The granules in the cluster of *B. rufescens* tend to segregate along the midline, forming a dark band. There are, however, numerous other granules scattered at random throughout the rest of the limiting membrane.

The gland-clusters in the species of this genus, as in the previously described genera, when intact, lie in a shallow cavity in the musculature of the lower jaw. The physical characters of the gland-clusters in the species examined of the genera *Lineotriton* and *Bolitoglossa* are presented in Table III.

## GENUS MAGNADIGITA Taylor

The gland-clusters in the genus *Magnadigita* are variable in shape, but relatively uniform in size. They are circular, somewhat triangular, or oval in the different species. They are characteristically thin and composed of many glands that are uniform in shape. In this genus, as in *Bolitoglossa,* there are dark granules of pigment in the limiting membrane situated between the bases of the glands. The limiting membrane is somewhat thicker than in the genus *Chiropterotriton,* and resembles that in *Bolitoglossa.*

Microscopically the epidermis covering the clusters in this genus is thicker than that in either *Chiropterotriton* or *Bolitoglossa,* but aside from this difference, the structure of the clusters is similar to that of the other genera, and in gross examination without the aid of a dissecting microscope, and without a count of the glands in each cluster, it would be difficult to differentiate them. There are, however, enough variations in numbers of glands in each cluster to distinguish the genera.

Microscopic sections of the gland-clusters of *M. nigroflavescens,* (Plate IV, fig. 6), shows the close relationship between the hedonic and mucous glands. There is no sharp line of separation between the two. The limiting membrane does not separate the two types of glands but seems to hold them together. The membrane, however, is not so thick over the mucous glands as it is over the hedonic glands. The mucous glands are much smaller and are more or less balloon-shaped, and their nuclei do not stain as intensely as do those of the hedonic glands. The mucous secretions stain blue rather than golden with Mallory's triple stain.

A view of the dorsal surface of the gland-cluster of *M. subpalmata* (Plate IV, fig. 4), shows a somewhat different structure than is seen in the clusters of the other species. The glands in the anterior part of the cluster of *M. subpalmata* are widely separated from each other. This separation of the glands is characteristic of all the specimens studied. The separations in the other parts of the cluster, however, are irregular.

The physical characteristics of the gland-clusters of the species investigated in this genus are given in Table IV, and drawings of the clusters are in Plate IV. As in the other genera and species discussed, the gland-clusters when intact, lie in a shallow cavity in the musculature of the lower jaw.

## GENUS THORIUS Cope

This Mexican genus of small salamanders is characterized by gland-clusters which are large in relation to the size of the animal, and are generally circular and flat. The number of glands per cluster varies greatly among the various species examined, but is relatively constant within each species. In general, the glands are more widely separated in all species than in the other genera. The cluster, when intact, lies flat in a shallow cavity in the musculature of the lower jaw, and is marked externally by a slight differential coloration of the skin covering the cluster, and in all species, except *Thorius sp.* (#29528, EHT-HMS), a slight elevation is present at the posterior border. The only microscopic differences detected in the structure of the gland-clusters of this genus and the others, were that the cluster is smaller, and that the glands are shorter and smaller in diameter than in the previously described genera. The relationship between cell nuclei, cells, and their position in the glands are the same as described for the other genera, as can be seen in Plate V, figure 8. The dermal layer and the limiting membrane while thinner than in the other genera, make up almost half of the thickness of the gland-cluster, and the dark granules found in the limiting membrane of some other genera are lacking in this genus, as in the gland-clusters of *Chiropterotriton.*

A view of the dorsal surface of the clusters of *T. macdougalli* and *T. pennatulus,* shows that the glands are irregular in size, the largest being up to ten times the size of the smallest. Also the glands are irregular in shape, being circular to broadly oval in cross-section. The same surface of *Thorius sp.* (a small undescribed form characterized by a small nostril), shows a corresponding irregularity in size among the glands, the largest being six to eight times the size of the smallest, and varying between circular and broadly oval in cross-sectional shape. Some of the glands in the clusters of *T. dubitus* are five to six times larger than others, and they vary in shape from circular to oval.

The physical characteristics of the gland-clusters of this genus are given in Table V, and drawings of the clusters are in Plate V.

## GENUS OEDIPINA Keferstein

The hedonic gland-clusters of the genus *Oedipina* differ markedly from those of the other genera investigated. The individual glands and their basic constituents are essentially the same as those in the other genera, but the glands, originating in a small area in the sub-

mandibular region, are long, slender tubules lying horizontally between the musculature of the lower jaw and the skin. They extend for a number of millimeters posteriorly in a fanlike manner. The number and length of the glands varies with each species, but the cluster in each is typically fan-shaped, with occasional specimens having the glands overlapping. The external pores are close together. The glands which connect with the more anterior pore openings are situated dorsal to the glands connecting with the more posterior pores.

The limiting membrane also differs in this genus. The glands have seemingly pushed almost through this membrane and seem to be nearly in contact with the muscular layers in the lower jaw; however, the glands are seen in microscopic section to be surrounded by a thin network of fibers similar to those found in the limiting membrane which separates them from the musculature. With the exception of being more elongate, the glands are similar in microscopic structure to those found in the other genera. The cells are arranged around the periphery of the glands with their long axes perpendicular to the long axes of the glands. The cell nuclei are elliptical to globular in shape and are situated at the bases of the cells, oriented so that their long axes are parallel to the long axes of the cells. Microscopic sections also show that the mucous glands are somewhat suppressed in the area immediately surrounding the external pores.

The gland-clusters in this genus are not easily observed because there is only a slight external elevation, and the color of the epidermis covering the clusters differs but little from that of the surrounding skin. The cluster is placed well forward, just posterior to the symphysis of the mentomeckelian bones.

No microscopic sections were made of the clusters of *O. uniformis* and *O. bonitaensis*. Probably, however, the structure is similar to that of *O. Cyclocauda*, since they resemble each other in macroscopic structure. The minor differences in structure make identification of the gland-clusters of this genus easy, both macroscopically and microscopically. Descriptions of the physical characteristics of the gland-clusters of the species of *Oedipina* investigated are in Table VI, and drawings of the individual clusters are found in Plate VI.

## Specific and Generic Relationships as Indicated by the Structure of the Gland-clusters

It is evident from the preceding material that there is a definite resemblance in position, size and shape of the mental hedonic gland-clusters of the various species and genera investigated. It is doubtful that one could differentiate the cluster of any given species or even genus from microscopic sections alone; the exception, of course, being *Oedipina*. The similarity mentioned is interesting, but not surprising when one considers that there is a corresponding similarity between many of the homologous structures in the genera of almost every taxonomic family in the Animal Kingdom.

There are enough macroscopic variations among the different genera and species for one to be able to establish some relationships between them. Of the variations of a major type, the most evident is the elongation and recumbent position of the glands in the gland-clusters of the genus *Oedipina*. The fact that the glands in the clusters of *Oedipina* have been able to penetrate into and almost through the limiting membrane is significant, because this character has not been developed in the clusters of the other genera. The gland-clusters in *Oedipina* are, therefore, considered highly specialized.

The other species and genera examined show little variation in the degree of development. The clusters of the species of *Pseudoeurycea* seem to be the most generalized of those examined, in that there is little differentiation in the size and shape of the clusters, and the individual glands are only slightly varied, in number, size and shape. In the genera *Magnadigita, Bolitoglossa* and *Chiropterotriton* the clusters, as well as the individual glands are more variable in size and shape, and thus seem somewhat more highly differentiated. The genus *Lineotriton* probably also belongs with this latter group.

The larger species of the genus *Bolitoglossa* have larger gland-clusters composed of more numerous glands than the smaller species; while in *Magnadigita* and *Pseudoeurycea* the larger species (*M. robusta* and *P. bellii*) have smaller clusters containing fewer glands than do the medium sized species of these genera.

There is a remarkable similarity between the gland-clusters of *Magnadigita pesrubra, Bolitoglossa mexicana, B. schmidti* and *Pseudoeurycea c. cephalica*. There are minor differences but the cluster of *P. c. cephalica* is the most obviously different in that it contains fewer glands. The clusters of *Bolitoglossa mexicana* and

*B. schmidti* differ somewhat in size, but both have approximately the same number of glands, and the glands of both species are irregular in size and shape. The cluster of *Magnadigita pesrubra* also has the same dimensions, as well as an equal number of glands, but differs from the others in that the glands are notably uniform in size and shape.

The gland-clusters of the subspecies *Pseudocurycea c. cephalica* and *P. c. rubrimembris* differed markedly in shape and number of glands, those of the latter being an elongate oval and containing more glands. The relationship of the individual glands within each cluster, however, is similar in that in both they are non-uniform in size and shape, and are closely approximated.

The gland-clusters found in *Bolitoglossa rufescens* differ from those of the rest of the genus. The animal is small but has a relatively small cluster. The shape is somewhat similar to that in *B. striatula* and *B. veracrucis,* but differs markedly from the rest. It is less than half as large proportionally as any other cluster seen in the genus, and contains by far the smallest number of glands. The individual glands are similar to those seen in *B. platydactyla, B. mexicana,* and *B. schmidti* only in that they are non-uniform in size and shape, and showed the same microscopic morphology.

If the species of the genus *Chiropterotriton* are divided as to habitat, it is noticed that the arboreal forms (*C. arborea* and *C. lavae*) have a cluster similar in size and shape to the terrestrial forms, but containing two to three times more glands. The cluster of *C. multidentata,* which is found in both habitats, is intermediate between the arboreal and terrestrial forms in number of glands, having more than the terrestrial species and less than the arboreal species. Of the terrestrial forms, however, *C. chondrostega* which has never been taken from bromelias, but has been found only under rocks in open terrain, has almost the same number of glands as the arboreal species. The number of its glands suggests that it is either related in some manner to the arboreal forms, or that it is a somewhat aberrant terrestrial form. The number of glands may in some manner be associated with habit and habitat.

In the genus *Thorius, T. dubitus, T. macdougalli, Thorius sp.,* and *T. pennatulus* show considerable variation in the relative size and shape of the individual glands. In the other species of this genus, however, the gland-clusters varied but little from those in the genera *Magnadigita, Bolitoglossa* and *Chiropterotriton,* except that, owing to the much smaller size of the animals, the clusters were smaller.

If the external pressure applied to the glands during courtship is the stimulus required to cause secretion, it would be of interest to know what effect pressure would have on a gland of the type found in *Oedipina.* It is not known whether the chin of the male is moved from side to side, or from anterior to posterior during courtship. If the latter type of movement is utilized the secretions probably would be thrust forward and then expelled. If, on the other hand, the movement is lateral, it would seem difficult for the secretions to be forced out of the glands.

## SUMMARY

1. In the family *Plethodontidae,* the mental hedonic gland-cluster is embedded in the skin immediately posterior to the symphysis of the mentomeckelian bones in the submandibular region of the males.
2. Macroscopic and microscopic examination showed that the gland-clusters of the genus *Oedipina* are the most specialized in size, shape and development.
3. The gland-clusters of the other genera show varying degrees of specialization; the clusters of *Pseudoeurycea* are the most generalized and those of *Chiropterotriton, Bolitoglossa,* and *Magnadigita* are somewhat more specialized. The clusters seen in the genus *Thorius* stand somewhere between those of *Oedipina* and those of other genera. The cluster of only one specimen of *Lineotriton lineola* was available for investigation, however, it also appears to belong in this group.
4. There are certain intergeneric, interspecific and intraspecific relationships in the clusters of the various genera and species which may depend on habitat, breeding habits, and other factors not fully considered in this investigation.
5. In all the species examined within a given genus, the clusters of *Bolitoglossa rufescens* seem to be the most aberrant in form.

## LITERATURE CITED

GUYER, M. F.
1921. Animal Micrology, Rev. Ed., The University of Chicago Press, Chicago, Ill., pp. 1-289, figs. 1-74.

NOBLE, G. K.
1927. The relation of courtship to the secondary sexual characters of the two lined salamander *Eurycea bislineata* (Green). Amer. Mus. Novitates, No. 362, 1927, pp. 1-5.
1931. The biology of the amphibia. McGraw-Hill Book Co., Inc., New York, pp. 1-577, figs. 1-177.

SMITH, R. E.
1941. Mating behavior in *Triturus torosus* and related newts. Copeia, 1941, No. 4, pp. 255-262.

TANNER, W. W.
1950. A new genus of plethodontid salamanders from Mexico. Great Basin Nat., vol. 10, Nos. 1-4, Oct. 10, 1950, pp. 37-44.

TAYLOR, E. H.
1944. The genera of plethodontid salamanders in Mexico, Pt. I. Univ. Kansas Sci. Bull., vol. 33, pt. 1, No. 12, May 15, 1944, pls. XII-XV, text figs. 1, 2.

## TABLE I

### PHYSICAL CHARACTERISTICS OF THE GLAND-CLUSTERS OF THE GENUS *PSEUDOEURYCEA*

| | *P. c. cephalica* | *P. leprosa* | *P. gadovii* | *P. c. rubrimembris* | *P. bellii* |
|---|---|---|---|---|---|
| Length of cluster * | 2.5 | 2.8 | 3.0 | 2.2 | 2.4 |
| Width of cluster | 2.5 | 3.0 | 4.0 | 3.2 | 3.0 |
| Thickness of cluster | 0.6 | 0.8 | 1.0 | 0.5 | 0.5 |
| Shape of cluster | Circular. | Triangular; rounded posteriorly, blunt apex anterior. | Triangular; flattened posterior, blunt apex anterior. | Broadly oval. | Ovoid to circular. |
| Number of glands | 130 | 275 | 110 | 198 | 140 |
| Length of glands | 0.57 | Too distorted to measure. | Uniform (macroscopically) | Uniform (macroscopically) | 0.39 |
| Diameter of glands | 0.08—0.19 | Too distorted to measure. | Uniform (macroscopically) | Some 6—8 times larger than others. | 0.16 |
| Thickness of limiting membrane | 0.02 | 0.028 | Thinner than *P. leprosa.* | Approximately same as *P. c. cephalica.* | 0.03 |
| Granules of pigment | 5—7, dark and irregularly shaped. | Occasional group in posterior portion. | None. | Numerous, scattered at random. | Numerous, scattered at random. |
| Remarks | Individual glands distinctly separated. Granules of pigment segregated to areas between bases of glands. | Granules of pigment seem to be restricted to posterior part of cluster. | No microscopic sections made. | No microscopic sections made. Individual glands are separated in center of cluster; closely approximated around periphery. | |

* All measurements in mm.

## TABLE II

### PHYSICAL CHARACTERISTICS OF THE GLAND-CLUSTERS OF THE GENUS *CHIROPTEROTRITON*

| | *C. multidentata* | *C. terrestris* | *C. chiroptera* | *C. lavae* | *C. dimidiata* | *C. chondrostega* | *C. arborea* |
|---|---|---|---|---|---|---|---|
| Length of cluster | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 0.8 | 1.5 |
| Width of cluster | 2.0 | 1.5 | 1.5 | 1.5 | 1.0 | 1.0 | 2.0 |
| Thickness of cluster | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.4 | 0.8 |
| Shape of cluster | Ovoid, lateral borders broadly rounded. | Ovoid. | Triangular; base broadly rounded, blunt apex directed anteriorly. | Triangular; shape more sharply angular than *C. chiroptera*. | Broadly oval, bluntly pointed anteriorly. | Ovoid. | Broadly oval. |
| Number of glands | 75—80 | 48—50 | 50—52 | 170—175 | 60 | 160—170 | 205—207 |
| Length of glands | 0.2 | 0.33 | 0.5 | 0.33 | | 0.21 | 0.7 |
| Diameter of glands | 0.18 | 0.13 | 0.1 | 0.12 | Circular to almost rectangular in cross-section. | 0.16 | 0.16 |
| Thickness of limiting membrane | 0.02 | 0.02 | 0.02 | 0.02 | Approximatly same thickness as *C. lavae*. | 0.03 | 0.02 |
| Granules of pigment | None | None | None | None | None | None | None |
| External elevation of cluster | Marked, along lateraland posterior borders. | Slight, along posterior border. | Slight, along posterior border. | Center of cluster elevated more than posterior border. | Slight, along posterior border. | Rounded with peak at center. | Slight elevation along posterior border. |
| External coloration of cluster | Lighter than surrounding area. | Lighter than surrounding area. | Slightly lighter than surrounding area. | Markedly lighter than surrounding area. | Slightly lighter than surrounding area. | Slightly lighter than surrounding area. | Slightly lighter than surrounding area. |
| Remarks | Bases of glands circular to almost rectangular in cross-section. Glands separated in some areas, closely approximated in others. | Glands distictly separated from each other. | Glands in center of cluster are distinctly separated from each other. | | No microscopic sections made. | Glands closely approximated. | Trilobate appearance of cluster. |

TABLE III

PHYSICAL CHARACTERISTICS OF THE GLAND-CLUSTERS OF THE GENERA *LINEOTRITON* AND *BOLITOGLOSSA*

| | *L. lineola* | *B. mexicana* | *B. platydactyla* | *B. striatula* | *B. flaviventris* | *B. veracrucis* | *B. rufescens* | *B. schmidti* |
|---|---|---|---|---|---|---|---|---|
| Length of cluster... | 1.2 | 3.2 | 5.2 | 4.5 | 4.0 | 2.9 | 1.5 | 2.6 |
| Width of cluster... | 1.2 | 3.2 | 5.9 | 4.8 | 4.0 | 4.0 | 1.8 | 2.8 |
| Thickness of cluster... | 0.3 | 1.0 | 0.6 | 0.5 | 0.2 | 0.4 | 0.2 | 0.8 |
| Shape of cluster... | Circular. | Circular. | Ovoid; see text. | Cordiform; apex directed anteriorly. | Cordiform; apex directed anteriorly. | Cordiform; broadened laterally. | Cordiform; lateral borders in anterior part concave. | Circular. |
| Number of glands... | 198 | 225—235 | 330—340 | 500 | 400 | 400 | 150—160 | 200 |
| Length of glands... | | 0.66 | | | Relatively short. | Longer than in *B. flaviventris.* | 0.16 | |
| Diameter of glands... | Oval in cross-section. | 0.22 | Nonuniform in diameter. | Uniform in diameter. | Uniform in diameter. | Nonuniform in diameter. | 0.10 | Nonuniform in diameter. |
| Thickness of limiting membrane | | 0.2 | Approximately the same as *B. mexicana.* | Thicker than *B. mexicana.* | | | 0.05 | Thinner than in *B. rufescens.* |
| Granules of pigment | Occasional clusters scattered at random. | Numerous, segregated to median anterior third of cluster. | Numerous, scattered at random. | Numerous, scattered in anterior part. | None. | 5—8 granules segregated in anterior part. | Form dark anterior-posterior band along mid-line. | Occasional, scattered at random. |
| External elevation of cluster | Along lateral and posterior borders. | Marked, along posterior border. | Entire surface of cluster elevated. | None. | Slight, along posterior border. | Marked, along posetrior border. | None. | Marked, along posetrior border. |
| External coloration of cluster | Slightly lighter than surrounding area. | Lighter than surrounding area. | Markedly lighter than surrounding area. | Slightly lighter than surrounding area. | None; color of cluster same as venter of animal. | Lighter than surrounding area. | None; color of cluster same as venter of animal. | None; color of cluster same as that of venter of animal. |
| Remarks.... | No microscopic sections made. | | No microscopic sections made. Cluster had definite yellowish color. Individual glands widely separated. | No microscopic sections made. Individual glands relatively small and closely approximated. | No microscopic sections made. Glands closely approximated. | No microscopic sections made. | | No microscopic sections made. Glands closely approximated. |

## TABLE IV

### PHYSICAL CHARACTERISTICS OF THE GLAND-CLUSTERS OF THE GENUS *MAGNADIGITA*

| | *M. torresi* | *M. pesrubra* | *M. nigroflavescens* | *M. subpalmata* | *M. robusta* |
|---|---|---|---|---|---|
| Length of cluster | 2.5 | 2.5 | 2.5 | 2.8 | 4.5 |
| Width of cluster | 2.5 | 3.0 | 2.6 | 3.3 | 3.5 |
| Thickness of cluster | 0.4 | 0.4 | 0.3 | 1.1 | 0.9 |
| Shape of cluster | Circular. | Circular. flattened along posterior border. | Circular. | Somewhat cordiform; bluntly pointed anteriorly, posterior border slightly concave. | Elongate oval; bluntly pointed anteriorly, posterior broadly rounded. |
| Number of glands | 250 | 200 | 180—185 | 195—200 | 180 |
| Length of glands | | | 0.25 | 1.0 | Shorter than *M. subpalmata.* |
| Diameter of glands | Uniform in diameter. | Uniform in diameter. | 0.18 | 0.19 | Nonuniform in diameter. |
| Thickness of limiting membrane | Relatively thick. | Approximately the same as *M. torresi.* | 0.01 | 0.01 | Appears thicker than in *M. subpalmata.* |
| Granules of pigment | Numerous, scattered at random. | 8—10 granules along antero-posterior midline. | 15—18 granules scattered at random. | Occasional, scattered at random. | Occasional cluster of granules scattered at random. |
| External elevation of cluster | Marked, along posterior border. | Slight, along posterior border. | None. | Marked, along posterior border. | Whole cluster strongly elevated. |
| External coloration of cluster | Markedly lighter than surrounding area. | Markedly lighter than surrounding area. | Slightly lighter than surrounding area. | Markedly lighter than surrounding area. | Markedly lighter than surrounding area. |
| Remarks | No microscopic sections made. Glands closely approximated. | No microscopic sections made. | | Glands in anterior part separated. Granules of pigment not restricted to areas between bases of individual glands. | No microscopic sections made. Glands around periphery smaller in diameter and closely approximated, those in center larger in diameter and widely separated. |

## TABLE V

### PHYSICAL CHARACTERISTICS OF THE GLAND-CLUSTERS OF THE GENUS *THORIUS*

| | *T. narisovalis* | *T. pulmonaris* | *T. macdougalli* | *Thorius sp.* | *T. pennatulus* | *T. dubitus* | *T. troglodytes* |
|---|---|---|---|---|---|---|---|
| Length of cluster | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1.1 |
| Width of cluster | 1.1 | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 | 0.8 |
| Thickness of cluster | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 |
| Shape of cluster | Circular. | Circular. | Circular. | Circular. | Circular. | Elongate oval. | Somewhat cordiform, bluntly pointed posteriorly. |
| Number of glands | 99 | 140 | 50 | 42 | 17 | 64 | 70 |
| Length of glands | 0.16 | Shorter than *T. narisovalis.* | | | | | |
| Diameter of glands | 0.1 | Uniform in diameter. | Nonuniform. | Nonuniform. | Nonuniform. | Nonuniform. | Uniform. |
| Thickness of limiting membrane | 0.015 | Approximately the same as *T. narisovalis.* | Seems thicker than *T. narisovalis.* | Approximately the same as *T. narisovalis.* | Thicker than *T. narisovalis.* | Approximately the same as *T. narisovalis.* | Thicker than *T. narisovalis.* |
| Remarks | | No microscopic sections made. | No microscopic sections made. Glands distinctly separated. | No microscopic sections made. | No microscopic sections made. | No microscopic sections made. Glands closely approximated. | No microscopic sections made. Glands closely approximated. |

## TABLE VI

### PHYSICAL CHARACTERISTICS OF THE GLAND-CLUSTERS OF THE GENUS *OEDIPINA*

| | *O. cyclocauda* | *O. uniformis* | *O. bonitaensis* |
|---|---|---|---|
| Position of external pores.. | In two irregular rows near the tip of the chin | In two distinct rows near the tip of the chin. | Form three or possibly four rows, appear somewhat as a circular group. |
| Shape of cluster..... | Fan-shaped. | Fan-shaped. | Fan-shaped. |
| Number of glands..... | 9 | 11 | 17 |
| Length of glands..... | 1.4 | 1.2—1.4 | 1.5—1.8 |
| Diameter of glands..... | 0.08 | Approximately the same as *O. cyclocauda.* | Approximately the same as *O. cyclocauda.* |
| Thickness of limiting membrane..... | 0.04 thickening to 0.1 around apices of glands. | Approximately the same as *O. cyclocauda.* | Approximately the same as *O. cyclocauda.* |
| Remarks..... | | No microscopic sections made. | No microscopic sections made. Diagrammatic sketch (Pl. VI, fig. 4.) |

## TABLE VII

### TABULATION OF CLUSTER SIZE AND GLAND NUMBERS

| Genus and species | Length in mm. | Width in mm. | Thickness in mm. | Number of glands | Snout to vent in mm. |
|---|---|---|---|---|---|
| Pseudoeurycea | | | | | |
| c. cephalica | 2.5 | 2.5 | 0.6 | 130 | 44.0 |
| leprosa | 2.8 | 3.0 | 0.8 | 275 | 48.0 |
| gadovii | 3.0 | 4.0 | 1.0 | 110 | 57.0 |
| c. rubrimembris | 2.2 | 3.2 | 0.5 | 198 | 43.0 |
| bellii | 2.4 | 3.0 | 0.6 | 140 | 93.0 |
| Chiropterotriton | | | | | |
| multidentata | 1.0 | 2.0 | 0.4 | 75—80 | 38.0 |
| terrestris | 1.0 | 1.5 | 0.5 | 48—50 | 26.5 |
| chiroptera | 1.0 | 1.5 | 0.5 | 50—52 | 25.0 |
| lavae | 1.0 | 1.5 | 0.6 | 170—175 | 33.0 |
| dimidiata | 1.1 | 1.0 | 0.6 | 60 | 24.7 |
| chondrostega | 0.8 | 1.0 | 0.4 | 160—170 | 29.0 |
| arborea | 1.5 | 2.0 | 0.8 | 205—207 | 34.8 |
| Lineotriton | | | | | |
| lineola | 1.2 | 1.2 | 0.3 | 198 | 34.5 |
| Bolitoglossa | | | | | |
| mexicana | 3.2 | 3.2 | 1.0 | 225—235 | 68.0 |
| platydactyla | 5.2 | 5.9 | 0.6 | 330—340 | 70.0 |
| striatula | 4.8 | 4.5 | 0.5 | 500 | 47.0 |
| flaviventris | 4.0 | 4.0 | 0.2 | 400 | 66.0 |
| veracrucis | 2.9 | 4.0 | 0.4 | 400 | 50.0 |
| rufescens | 1.5 | 1.8 | 0.2 | 150—160 | 31.0 |
| schmidti | 2.6 | 2.8 | 0.8 | 200 | 54.0 |
| Magnadigita | | | | | |
| torresi | 2.5 | 2.5 | 0.4 | 250 | 51.0 |
| pesrubra | 2.5 | 3.0 | 0.4 | 200 | 63.0 |
| nigroflavescens | 2.5 | 2.6 | 0.3 | 180—185 | 55.0 |
| subpalmata | 2.7 | 3.2 | 1.1 | 195—200 | 68.0 |
| robusta | 4.5 | 3.5 | 0.9 | 180 | 80.0 |
| Thorius | | | | | |
| narisovalis | 1.0 | 1.1 | 0.3 | 99 | 31.0 |
| pulmonaris | 0.8 | 0.9 | 0.2 | 140 | 27.2 |
| macdougalli | 0.8 | 0.8 | 0.2 | 50 | 20.7 |
| Thorius sp. | 0.8 | 0.8 | 0.2 | 42 | ..... |
| pennatulus | 0.8 | 0.8 | 0.2 | 17 | 21.2 |
| dubitus | 0.8 | 0.7 | 0.2 | 64 | 21.0 |
| troglodytes | 1.0 | 0.8 | 0.3 | 70 | 26.0 |
| Oedipina | | | | | |
| cyclocauda | 1.4 | 0.08 mm. | diameter | 9 | 43.0 |
| uniformis | 1.2—1.4 | | | 11 | 51.0 |
| bonitaensis | 1.5—1.8 | | | 17 | 56.0 |

## PLATE I

The Mental Hedonic Gland-clusters of the Genus *Pseudoeurycea*

FIG. 1. *Pseudoeurycea cephalica cephalica.* View of dorsal surface of gland-cluster, × 12.

FIG. 2. *Pseudoeurycea leprosa.* View of dorsal surface of gland-cluster, × 9.

FIG. 3. *Pseudoeurycea gadovii.* View of dorsal surface of gland-cluster, × 6.

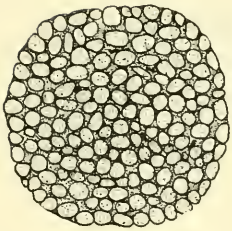
FIG. 4. *Pseudoeurycea cephalica rubrimembris.* View of dorsal surface of gland-cluster, × 10.

FIG. 5. *Pseudoeurycea bellii.* View of dorsal surface of gland-cluster, × 12.

FIG. 6. *Pseudoeurycea leprosa.* Longitudinal cross-section, × 48.

FIG. 7. *Pseudoeurycea bellii.* Longitudinal cross-section, × 23.

PLATE I



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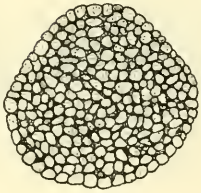

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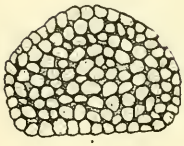

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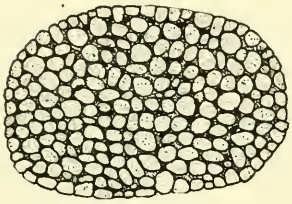

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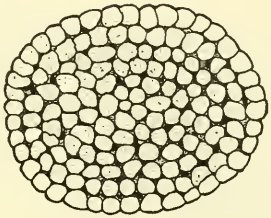

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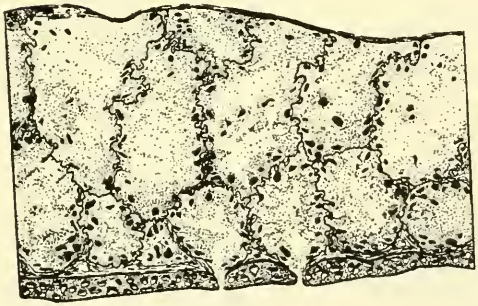

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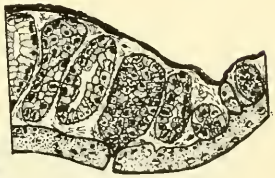


7.

## PLATE II

The Mental Hedonic Gland-clusters of the Genus *Chiropterotriton*

FIG. 1. *Chiropterotriton multidentata.* View of dorsal surface of gland-cluster, × 18.

FIG. 2. *Chiropterotriton terrestris.* View of dorsal surface of gland-cluster, × 19.

FIG. 3. *Chiropterotriton chiroptera.* View of dorsal surface of gland-cluster, × 19.

FIG. 4. *Chiropterotriton lavae.* View of dorsal surface of gland-cluster, × 19.

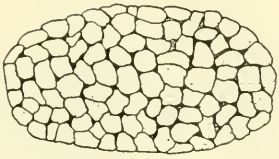
FIG. 5. *Chiropterotriton dimidiata.* View of dorsal surface of gland-cluster, × 19.

FIG. 6. *Chiropterotriton chondrostega.* View of dorsal surface of gland-cluster, × 19.

FIG. 7. *Chiropterotriton arborea.* View of dorsal surface of gland-cluster, × 19.

FIG. 8. *Chiropterotriton chiroptera.* Longitudinal cross-section, × 28.

PLATE II



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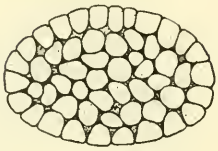

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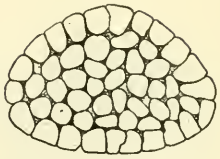

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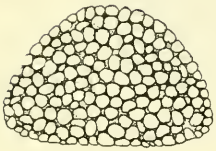

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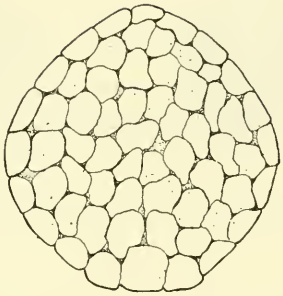

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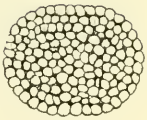

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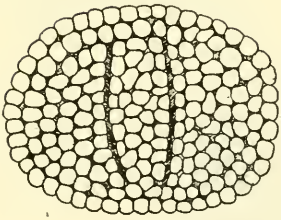

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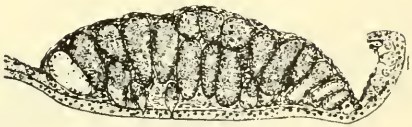

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## PLATE III

The Mental Hedonic Gland-clusters of the Genera *Lineotriton* and *Bolitoglossa*

FIG. 1. *Lineotriton lineola.* View of dorsal surface of gland-cluster, × 20.

FIG. 2. *Bolitoglossa mexicana.* View of dorsal surface of gland-cluster, × 10.

FIG. 3. *Bolitoglossa platydactyla.* View of dorsal surface of gland-cluster, × 5.

FIG. 4. *Bolitoglossa striatula.* View of dorsal surface of gland-cluster, × 7.

FIG. 5. *Bolitoglossa flaviventris.* View of dorsal surface of gland-cluster, × 5.

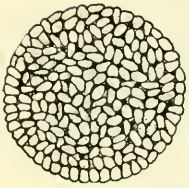
FIG. 6. *Bolitoglossa veracrucis.* View of dorsal surface of gland-cluster, × 10.

FIG. 7. *Bolitoglossa rufescens.* View of dorsal surface of gland-cluster, × 11.

FIG. 8. *Bolitoglossa schmidti.* View of dorsal surface of gland-cluster, × 10.

FIG. 9. *Bolitoglossa mexicana.* Longitudinal cross-section of gland-cluster, × 31.

PLATE III



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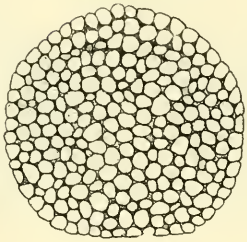

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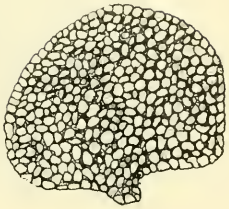

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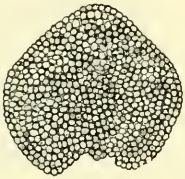

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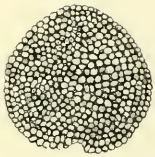

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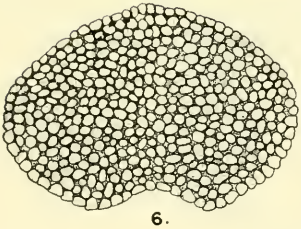

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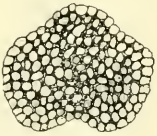

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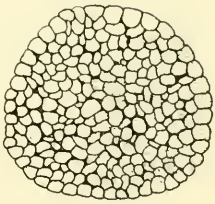

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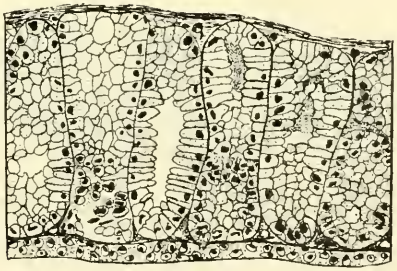


9.

## PLATE IV

The Mental Hedonic Gland-clusters of the Genus *Magnadigita*

FIG. 1. *Magnadigita torresi.* View of dorsal surface of gland-cluster, × 12.

FIG. 2. *Magnadigita pesrubra.* View of dorsal surface of gland-cluster, × 10.

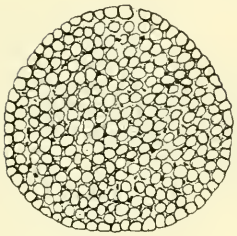
FIG. 3. *Magnadigita nigroflavescens.* View of dorsal surface of gland-cluster, × 12.

FIG. 4. *Magnadigita subpalmata.* View of dorsal surface of gland-cluster, × 12.5.

FIG. 5. *Magnadigita robusta.* View of dorsal surface of gland-cluster, × 12.

FIG. 6. *Magnadigita nigroflavescens.* Longitudinal cross-section, × 54.

PLATE IV



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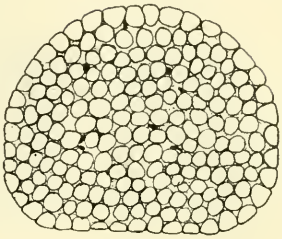

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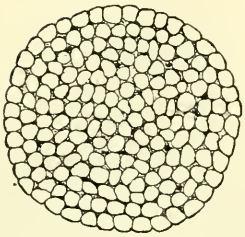

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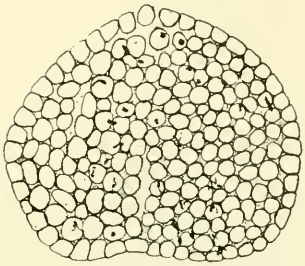

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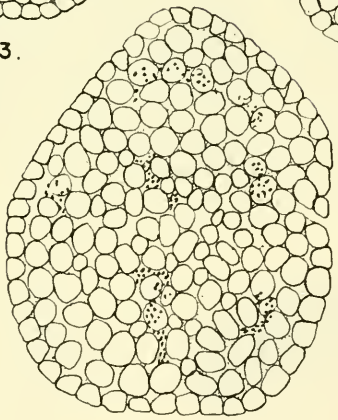

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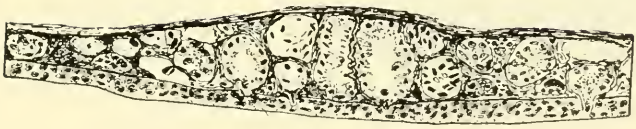

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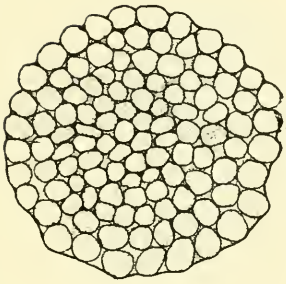
## PLATE V

The Mental Hedonic Gland-clusters of the Genus *Thorius*.

FIG. 1. *Thorius narisovalis.* View of dorsal surface of gland-cluster, × 39.
FIG. 2. *Thorius pulmonaris.* View of dorsal surface of gland-cluster, × 35.
FIG. 3. *Thorius macdougalli.* View of dorsal surface of gland-cluster, × 33.
FIG. 4. *Thorius sp.* View of dorsal surface of gland-cluster, × 35.
FIG. 5. *Thorius pennatulus.* View of dorsal surface of gland-cluster, × 33.
FIG. 6. *Thorius dubitus.* View of dorsal surface of gland-cluster, × 40.
FIG. 7. *Thorius troglodytes.* View of dorsal surface of gland-cluster, × 37.
FIG. 8. *Thorius narisovalis.* Longitudinal cross-section, × 113.

PLATE V



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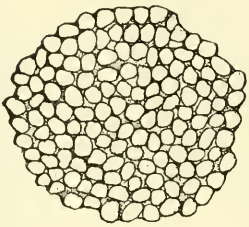

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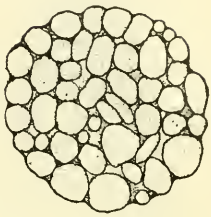

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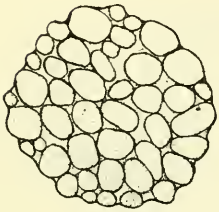

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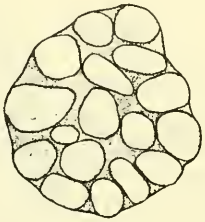

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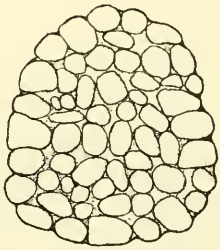

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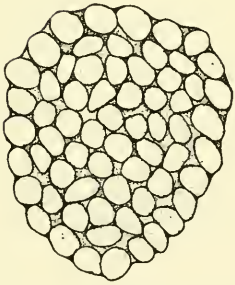

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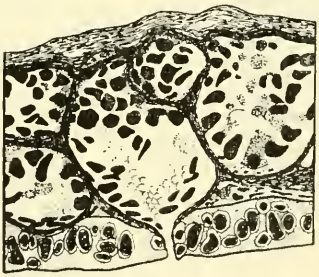

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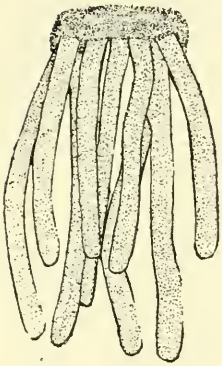
## PLATE VI

The Mental Hedonic Gland-clusters of the Genus *Oedipina*

FIG. 1. *Oedipina cyclocauda.* View of dorsal surface of gland-cluster, × 32.
FIG. 2. *Oedipina uniformis.* View of dorsal surface of gland-cluster, × 34.
FIG. 3. *Oedipina bonitaensis.* View of dorsal surface of gland-cluster, × 50.
FIG. 4. *Oedipina bonitaensis.* Lateral view of gland-cluster, × 50.
FIG. 5. *Oedipina cyclocauda.* Longitudinal cross-section, × 96.

PLATE VI



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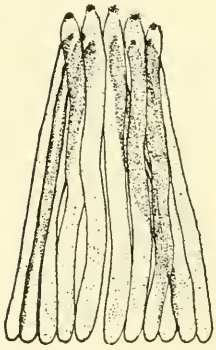

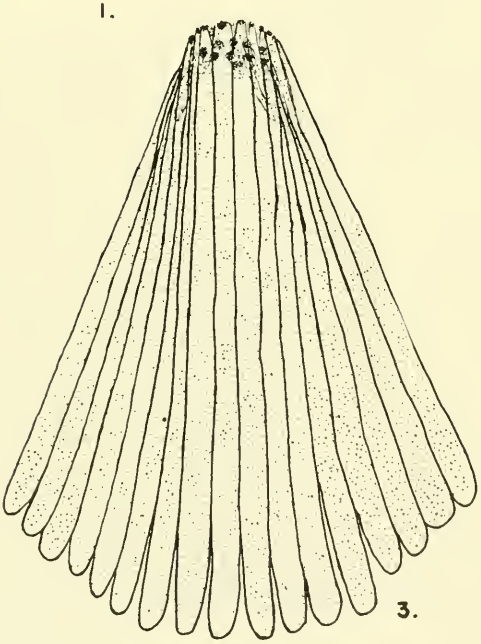

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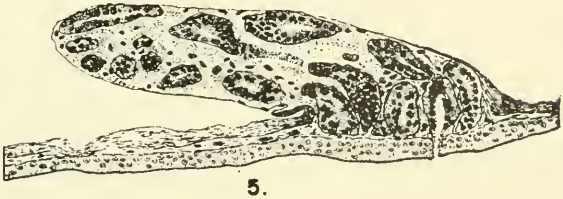

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXVI, PT. I] JUNE 1, 1954 [NO. 2

# The Effect of Protein Deficiency on the Submaxillary Lymph Nodes and Spleens of Albino Rats [1]

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Lawrence, Kansas

ABSTRACT: Differential cell counts were made in various areas of the submaxillary lymph nodes and spleens from three groups of young adult albino rats. The normal group received a diet containing 18 percent by weight of protein; of the two experimental groups, one received a diet containing 2 percent of protein and the other a diet completely deficient in protein for a period of 50 to 57 days.

Quantitative evidence is presented to show that the lymphatic nodule is the principal lymphocytopoietic center and a phagocytic center of the submaxillary lymph nodes and spleens of normal rats. As a result of protein deficiency, there was a depression of lymphocyte production in these areas and a peripheral lymphopenia. The phagocytic activity of the nodule was not affected. A slight compensatory lymphocyte production may have occurred in the internodular tissue of the lymph nodes, where the lymphocytopoietic activity appears to be minimal under normal conditions.

Erythrocytopoiesis, occurring normally only in the splenic cords, was stimulated in this area of the spleens from the 0 percent group and in the perifollicular envelope of the spleens from both groups of protein deficient animals. This may be an attempt to compensate for the decreased production of erythrocytes in the bone marrow. On the other hand, granulocytopoiesis appears to be depressed in the splenic cords of the 0 percent group of rats.

The production of plasma cells which occurred normally in the medullary cords of the lymph nodes and in the splenic cords was depressed as a result of the protein deficiency.

1. This investigation was supported by the Office of Naval Research, Grant N6 ori 220 T. O. 1.

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## INTRODUCTION

Protein is an important building block from which the tissues of the body are formed. Its dietary deficiency is known to cause many pathological changes, among which atrophy of the lymphoid organs has been noted (Jackson, '25; Stewart, '18). Asirvadham ('48) described in a general way a reduction in the number of lymphoid cells in the lymph nodes and spleens of rats fed a diet containing only 2 percent protein. He indicated that the lymphatic nodules of these organs were less active than normal. If single amino acids are deleted from the diet, the effect on the spleen seems to vary according to the missing amino acid. No alteration in the spleens was seen when either phenylalanine (Maun, Cahill, and Davis, '45a) or leucine (Maun, Cahill, and Davis, '45b) were absent. However, a histidine deficient diet resulted in atrophic spleens with small lymphatic nodules and the absence of germinal centers (Maun, Cahill, and Davis, '46).

None of the above reports included any detailed account of the cell population changes, nor any data on parts of the lymphoid organs other than the nodules. To the author's knowledge the only quantitative study of the cellular content of lymphoid organs was made by Kindred ('38, '40, '42) on normal rats. His findings will be discussed later.

In the present investigation an attempt has been made to determine the number of cells occurring in a $mm^3$ of tissue in several areas of the submaxillary lymph nodes and spleens from normal and protein deficient young adult albino rats and to relate the findings to the hemopoietic activity of these organs.

## MATERIALS AND METHODS

The submaxillary lymph nodes and spleens from three groups of rats were examined. The normal rats (18 percent group) received a diet containing 18 percent by weight of protein (casein), the second group (2 percent group) received a diet containing 2 percent protein and the third (0 percent group) was fed a diet completely deficient in protein. The three diets were isocaloric diets in which all constituents except protein (casein) and carbohydrate (sucrose) were present in identical amounts. In the two diets where the protein content was decreased the carbohydrate was increased a corresponding amount. A detailed description of the diets is presented elsewhere (Brown, '53). The experimental feeding period was begun at 29 days of age and continued for 50 to 57 days.

The submaxillary lymph nodes of eleven normal rats, eight 2 percent group rats, and nine 0 percent group rats; and the spleens from nine normal animals, seven 2 percent group rats and nine of the 0 percent group form the basis of this study.

The tissues were fixed in Zenker-formol solution, embedded in paraffin and sectioned serially at 8μ. All of the spleen and alternate lymph node sections were stained with hematoxylin-eosin-azure II. The remaining lymph node sections were stained with eosin-azure II.

In the submaxillary lymph node three areas were studied in each section: (1) the center of the lymphatic nodule (secondary nodule); (2) the internodular area, the diffuse lymphatic tissue of the cortex lying between the nodules; and (3) the medullary cord. The first two were counted in the sections stained with eosin-azure II and the third in sections stained with hematoxylin-eosin-azure II, which gives better differentiation of the plasma cells.

Differential cell counts were made in four areas of the spleens. Two of these were in the white pulp; the lymphatic nodule (secondary nodule) and the periarterial sheath; *i. e.*, the area of diffuse lymphatic tissue which surrounds the arteries. The third area studied was the perifollicular envelope (Krumbhaar, '48) or as Klemperer ('38) terms it, the marginal layer. This structure circumscribes the nodule, from which it is separated by a rind of connective tissue, and lacks sinuses. The fourth area chosen was in the cords of the red pulp: such cords lie between the sinusoids. For purposes of counting the cords were subdivided into the hemopoietic area, which contained many progenitors of both the granulocytes and erythrocytes as well as lymphocytes, and an area termed lymphatic, since it contained more lymphocytes and plasma cells and fewer myeloid and erythroid forms than did the hemopoietic area. The cells of the two areas in the cords were averaged together and reported as cells of the cords.

The cells in these areas were classified according to Maximow ('27) as follows: large, medium-sized, and small lymphocytes; reticular cells; plasma cells; macrophages (tingible Körpschen); erythroid cells; heterophils; and eosinophils. Both mature and immature forms were included in the counts of the latter three cell types, which occurred only in the spleens.

The camera lucida was employed in making the differential cell counts in the tissues. For each area described above the cells which occurred in a field 50μ square were sketched, counted, and classified according to type under oil immersion. Twelve equally distributed sections were studied in the organs of each rat. This revealed the

number of cells in a volume of 240,000$\mu^3$, from which the number of cells per mm$^3$ was computed.

The $\pm$ values represent the probable errors of the mean number of cells per mm$^3$. Both the Students t test and the significant ratio method were applied in order to determine the statistical significance of the changes in cell population in the experimental rats. Values were considered significant if they fell in the 5 percent level or below in the case of the Students t test and if their ratios were 3 or greater in the case of the other. Identical results were obtained by both methods.

## RESULTS

### SUBMAXILLARY LYMPH NODES

The distribution of several of the cell types in the normal submaxillary lymph nodes should be noted (Table 1). The populations of the large and medium-sized lymphocytes were greater in the nodule than in either of the other two areas; furthermore, the

TABLE 1

Differential cell counts in the submaxillary lymph nodes of young adult albino rats

The means $\pm$ the probable errors of each cell type per mm$^3$ of tissue. LL, large lymphocytes; MSL, medium-sized lymphocytes; SL, small lymphocytes; RET, reticular cells; MAC, macrophages; PLC, plasma cells.

| Area cell type | Nodule | Internodular area | Medullary cords |
|---|---|---|---|
| LL | 192,000 ± 15,000 | 49,200 ± 4,040 | 45,600 ± 8,240 |
| MSL | 3,330,000 ± 193,000 | 507,000 ± 48,100 | 645,000 ± 35,600 |
| SL | 3,190,000 ± 166,000 | 8,580,000 ± 179,000 | 2,680,000 ± 128,000 |
| RET | 422,000 ± 21,700 | 541,000 ± 35,000 | 201,000 ± 3,100 |
| MAC | 31,800 ± 6,030 | ..... | ..... |
| PLC | ..... | ..... | 2,260,000 ± 143,000 |

small and medium-sized lymphocytes occurred in approximately equal numbers. This was the only area where macrophages appeared with any consistency and in large enough numbers to warrant recording. In the internodular area the predominate cell type was the small lymphocyte. This cell type and the plasma cell constituted the major part of the cellular population of the medullary cords. The latter area was the only one in which plasma cells were observed.

Figure 1 shows that in the lymphatic nodule of the submaxillary lymph nodes the large lymphocyte population was not appreciably

altered by the 2 percent protein diet. However, this cell type was significantly decreased to almost half the normal number in the rats receiving the 0 percent protein diet. The numbers of medium-sized lymphocytes in this area were significantly decreased in both the 2 percent and 0 percent groups. On the other hand, the small lymphocyte and reticular cell populations were both increased to a significant extent. In both groups of protein deficient rats the macrophage population was essentially normal. With the exception of the large lymphocytes, all cell types were apparently affected to about the same degree by the two deficient diets.

In the internodular area of the lymph nodes (fig. 1) of the 2 percent and 0 percent groups, the large lymphocyte and reticular cell populations were essentially normal. The number of medium-sized lymphocytes was significantly larger, whereas the small lymphocyte population decreased. There was no significant difference between the numbers of any of the cell types in the 2 percent group and those in the 0 percent group.

The numbers of large lymphocytes in the medullary cords (fig. 1) of the lymph nodes from the rats fed the protein deficient diets were highly variable and showed no significant change from normal. The population of medium-sized lymphocytes was significantly decreased in the 2 percent group only. In both the 2 percent and 0 percent groups the number of small lymphocytes increased to a significant degree. Only the 0 percent protein diet resulted in a significantly increased number of reticular cells. The population of plasma cells was well below the normal in the two experimental groups, the reduction being greater in the 2 percent group. It is interesting to note that the change in plasma cells was greater than that shown by any other cell type in the lymph nodes.

## SPLEEN

The cell counts in the spleens of both the normal and protein deficient rats were highly variable. Because of this fact the populations of relatively few cell types appeared to be altered to a statistically significant degree by the deficient protein intake. The only cell types which did not exhibit this extreme variability were the small lymphocytes and reticular cells.

The cellular populations of the four areas of the normal spleens are tabulated in Table 2. It can be seen that the predominant cell in each of the areas was the small lymphocyte. As in the case of the lymph nodes, the large and medium-sized lymphocytes were more numerous in the nodule than in any of the other areas in the spleen

TABLE 2

Differential cell counts in the normal spleens of young adult albino rats

The means ± the probable errors of each cell type per mm³ of tissue. LL, large lymphocytes; MSL, medium-sized lymphocytes; SL, small lymphocytes; RET, reticular cells; MAC, macrophages; EOS, eosinophils; HET, heterophils; PLC, plasma cells; ERY, erythroid cells.

| Cell type | Nodule | Periart. sheath | Perifoll. envelope | Cord |
|---|---|---|---|---|
| LL..... | 160,000 ± 19,200 | 7,870 ± 1,160 | 8,800 ± 1,890 | 18,100 ± 2,350 |
| MSL... | 1,090,000 ± 95,300 | 94,300 ± 10,300 | 337,000 ± 75,800 | 265,000 ± 29,100 |
| SL..... | 6,260,000 ± 233,000 | 9,190,000 ± 316,000 | 5,770,000 ± 65,500 | 4,260,000 ± 69,600 |
| RET... | 210,000 ± 14,800 | 225,000 ± 12,200 | 176,000 ± 10,700 | 177,000 ± 7,250 |
| MAC... | 29,000 ± 4,440 | ..... | ..... | ..... |
| EOS.... | ..... | ..... | 4,170 ± 860 | 66,600 ± 8,420 |
| HET... | ..... | ..... | 11,100 ± 2,480 | 73,400 ± 4,650 |
| PLC... | ..... | ..... | ..... | 70,200 ± 6,700 |
| ERY... | ..... | ..... | ..... | 155,000 ± 16,600 |

studied. The perifollicular envelope contained all sizes of lymphocytes, mature heterophils and eosinophils, and a few immature forms of the latter two cell types. The cords of the red pulp contained cells representing all the developmental stages of the eosinophils, heterophils, and erythrocytes, as well as lymphocytes.

In the splenic nodules of both the 2 percent and 0 percent groups (fig. 2), the medium-sized lymphocyte populations were significantly reduced. The population of large lymphocytes was decreased and that of the small lymphocytes was increased in the splenic nodules of the 0 percent group, while in the case of the 2 percent group the numbers of these two cell types were within the normal range. Likewise, the reticular cell populations of the two experimental groups remained unchanged.

The populations of the large and medium-sized lymphocytes in the periarterial sheaths of the 0 percent group were significantly decreased to 13 percent and 52 percent of the normal values, respectively. All other cell types in the 0 percent group and all those in the 2 percent group were essentially normal in number.

In the perifollicular envelope, where no erythrocyte precursors occurred normally, there appeared an average of 33,300 ± 7,600 and 32,600 ± 8,000 immature red cells per mm³ in the 0 percent and 2 percent groups, respectively. The only other statistically significant change to occur in this area was a decrease in the number of

small lymphocytes of the 2 percent group to 87 percent of their normal value.

In the splenic cords of the protein deficient rats (fig. 2), the large lymphocytes and reticular cells were significantly increased in number, while the plasma cell populations were greatly decreased. The deficient diets did not appear to affect the number of medium-sized lymphocytes in this area. In the rats fed the 0 percent protein diet the populations of small lymphocytes, eosinophils and heterophils were decreased to a significant extent and the erythroid cell population was increased; on the other hand, in the 2 percent group these cell types were essentially normal in number.

## DISCUSSION

The function of the nodules of lymphatic tissue has been a controversial subject for many years. The literature on the subject has been well reviewed by Bloom ('38) and there is no need to go into the details here except to mention briefly the various theories. One group contends that the nodule is an important, but not the sole, site for lymphocytopoiesis (a germinal center). Another group holds that it is not a germinal center but rather a reaction center; *i. e.*, a site of bacterial and toxin inactivation and a phagocytic center where lymphocytes are destroyed. Recently Andrew and Andrew ('48) concluded, after a study of the age changes in the lymph nodes of rats, that the latter theory was the more probable. Maximow ('28) and Conway ('37) claim that the nodule undergoes cyclic changes; a resting nodule develops into a lymphocytopietic center (an active nodule or germinal center) and later degenerates and becomes a center for the destruction of lymphocytes (a reaction center). On the other hand, Kindred ('38) concluded that the nodule of the rat is both lymphocytopoietic and phagocytic at the same time. He has shown that the nodule of the lymph node has a light zone and a dark zone and that both lymphocytopoiesis and phagocytosis are characteristic of the dark zone where a larger number of medium-sized lymphocytes and mitotic figures occur. Phagocytosis alone is characteristic of the light zones. Later Kindred ('42) demonstrated that the dark zone of the nodule produces more small lymphocytes than any other area of the submaxillary lymph node of the albino rat. The nodules of the spleen are similar to those of the lymph node except that they were found not to be divided into the two zones (Kindred, '38). Kindred concluded that lymphocytopoiesis and phagocytosis occurred diffusely in the splenic nodules.

In the present study, counts were made in the center of the nodules of the submaxillary lymph nodes without regard for the light and dark zones. The results which were obtained approximated those which Kindred ('38) reported for the light zone in that the medium-sized and small lymphocytes occurred in nearly equal numbers with smaller numbers of large lymphocytes, reticular cells, and macrophages. These figures are intermediate between Maximow's resting nodule which contained mostly small lymphocytes and his active nodule where the medium-sized lymphocytes predominated (Maximow, '28).

The mother cell of the blood lymphocyte, which is primarily the small lymphocyte, is believed to be the medium-sized lymphocyte. It is the most active cell mitotically (Maximow, '28; Conway, '37; Kindred, '38) and normally produces the greatest number of small lymphocytes, some of which remain in the tissues for its maintenance and others of which eventually pass into the blood stream (Kindred, '42). However, the large lymphocyte can give rise to the medium-sized lymphocytes and subsequently the small lymphocyte. In addition, the small lymphocyte contributes to its own source by hypertrophying into medium-sized lymphocytes.

In view of these facts, the greater populations of large and medium-sized lymphocytes, especially the latter, in the nodule would indicate that this area is the most important site for lymphocytopoiesis in the submaxillary lymph nodes from the normal rats of this study. The presence of relatively small numbers of macrophages filled with nuclear debris indicates that this area is also a site of phagocytosis of lymphocytes.

In accordance with Kindred ('42), the splenic nodules of the normal rats also appear to be both phagocytic and lymphocytopoietic since they were found to contain macrophages and a greater number of medium-sized and large lymphocytes than any other area of the spleens studied. Contrary to Kindred's finding that the medium-sized lymphocyte was the predominating cell type in the splenic nodule, this study showed the small lymphocyte to be the most numerous. The fact that the medium-sized and large lymphocyte populations were smaller in the splenic nodule than in the lymph node nodule might be taken to mean that the splenic nodules were less active than those of the submaxillary lymph nodes.

The decreased numbers of lymphocyte stem cells, the medium-size and large lymphocytes, indicates that lymphocyte formation in the nodules of the submaxillary lymph nodes and spleens from the rats fed the 0 percent protein diet was decreased. The depression

of lymphocytopoietic activity was less pronounced in the 2 percent group since only the medium-sized lymphocytes were decreased in number; furthermore, their reduction was less marked than in the 0 percent group. Since the numbers of phagocytes were not significantly altered in the nodule, the phagocytic activity of this area does not appear to be affected by the deficient diets. The quantitative evidence for decreased lymphocytopoiesis in the lymphatic nodule of the protein deficient rats is in agreement with the qualitative results of Asirvadham ('48).

The decreased lymphocytopoiesis in the nodules of the submaxillary lymph nodes and spleens from the protein deficient rats is accompanied by a peripheral lymphopenia (Brown, '53). Although the mitotic rates and disposition of lymphocytes in other parts of the body are not known, the evidence presented indicates that the periphereal lymphopenia was due, at least in part, to the depression of lymphocyte formation in the organs studied.

The decreased small lymphocyte and increased medium-sized lymphocyte populations in the internodular area of the lymph nodes of the protein deficient rats might indicate that the small lymphocytes have hypertrophied to form medium-sized lymphocytes. This, in turn, suggests that the internodular area has increased its capacity for lymphocyte formation in an attempt to compensate for the decreased activity of the nodule.

The depressed plasma cell and increased small lymphocyte populations in the medullary cords of the lymph nodes from the two groups of protein deficient rats might be explained in accordance with the hypothesis that the plasma cells arise by individual hypertrophy of the various sized lymphocytes (Bloom, '38). Assuming this to be true, it would appear that the small lymphocytes in this area were not transformed into plasma cells but that they remained as lymphocytes. Therefore, the plasma cells decreased and the small lymphocytes increased in number. In any event the plasma cell production was certainly depressed. Lymphocytopoiesis appears to be interfered with only in the 2 percent group where the medium-sized lymphocytes were reduced in number.

The lymphocytopoietic activity of the periarterial sheaths of the spleens is probably only very slight in the normal rats as manifested by the very small numbers of lymphocyte precursors (large and medium-sized lymphocytes). Since the numbers of these cells were considerably decreased in the 0 percent group, the lymphocytopoietic activity appears to be even less. The activity of this

area in the white pulp of the spleens from the 2 percent group seems to be normal.

In addition to the lymphocytopoietic activity, the spleens of the normal rats exhibited myelo- and erythro-cytopoietic activity as manifested by the presence in the cords, of cells representing all the developmental stages of the granulocytes and erythrocytes.

In the cords of the 0 percent group, erythrocytopoiesis was increased as evidenced by the great increase in the number of red cell precursors. The increased population of large lymphocytes and reticular cells in this area might indicate an increased proliferation of these cells to provide stem cells from which the increased number of erythroid cells could be formed. Hypertrophy of the small lymphocytes may have been one source of the augmented large lymphocyte population. This would account for the reduced number of small lymphocytes. A decreased granulocytopoiesis in this area was manifested by a decreased number of cells of both the eosinophil and heterophil series. Apparently the 2 percent protein diet was not a sufficiently great stimulus to affect the processes of red cell and granulocyte production in the spleen, since the cell types involved were not significantly affected.

The presence of erythrocyte precursors in the splenic perifollicular envelope of both groups of protein deficient rats indicates that this area, which normally does not show erythrocytopoietic activity, was stimulated to produce red blood cells. This finding is in agreement with the belief of Krumbhaar ('47) that the perifollicular envelope is an auxillary hemopoietic tissue.

The increased erythrocytopoietic activity of these two areas of the spleens might be considered as an attempt on the part of the spleen to compensate for the decreased red cell formation in the bone marrow (Brown, '53). However, it is insufficient to maintain a normal blood erythrocyte level.

## SUMMARY

Differential cell counts were made in various areas of the submaxillary lymph nodes and spleens from three groups of young adult albino rats. The normal group received a diet containing 18 percent by weight of protein; of the two experimental groups, one received a diet containing 2 percent of protein and the other a diet completely deficient in protein for a period of 50 to 57 days.

Quantitative evidence is presented to show that the lymphatic nodule is the principal lymphocytopoietic center and a phagocytic center of the submaxillary lymph nodes and spleens of normal rats.

As a result of protein deficiency, there was a depression of lymphocyte production in these areas and a peripheral lymphopenia. The phagocytic activity of the nodule was not affected. A slight compensatory lymphocyte production may have occurred in the internodular tissue of the lymph nodes, where the lymphocytopoietic activity appears to be minimal under normal conditions.

Erythrocytopoiesis, occurring normally only in the splenic cords, was stimulated in this area of the spleens from the 0 percent group and in the perifollicular envelope of the spleens from both groups of protein deficient animals. This may be an attempt to compensate for the decreased production of erythrocytes in the bone marrow. On the other hand, granulocytopoiesis appears to be depressed in the splenic cords of the 0 percent group of rats.

The production of plasma cells which occurred normally in the medullary cords of the lymph nodes and in the splenic cords was depressed as a result of the protein deficiency.

## LITERATURE CITED

ANDREW, W., and ANDREW, N. V.
1948 Age Changes in the Deep Cervical Lymph Nodes of 100 Wistar Institute Rats. Amer. Jour. Anat., vol. 82, pp. 105-165.

ASIRVADHAM, M.
1948 Bone Marrow and its Leucocytic Response in Protein Deficiency. Infect. Dis., vol. 83, pp. 87-100.

BLOOM, W.
1938 Lymphatic Tissue; Lymphatic Organs. Handbook of Hematology. Hal Downey, Ed. Paul B. Hoeber, Inc., New York, vol. 2, pp. 1429-1467.

BROWN, J. W.
1954 The Effect of Protein Deficiency on the Bone Marrow and Peripheral Blood of Young Albino Rats. Univ. Kansas Sci. Bull., vol.36, pp. 55-68.

CONWAY, E. A.
1937 Cyclic Changes in Lymphatic Nodules. Anat. Rec., vol. 69, pp. 487-513.

JACKSON, C. M.
1925 The Effects of Inanitition and Malnutrition upon Growth and Structure. Blakiston's Son and Co., Philadelphia.

KLEMPERER, P.
1938 The Spleen. Handbook of Hematology. Hal Downey, Ed. Paul B. Hoeber, Inc., New York, vol. 3, pp. 1589-1776.

KINDRED, J. E.
1938 A Quantitative Study of the Lymphoid Organs of the Albino Rat. Amer. Jour. Anat., vol. 62, pp. 453-473.
1940 A Quantitative Study of the Hemopoietic Organs of Young Albino Rats. Ibid., vol. 67, pp. 99-149.

1942 A Quantitative Study of the Hemopoietic Organs of young Adult Albino Rats. Ibid., vol. 71, pp. 207-243.

KRUMBHAAR, E. B.

1948 A Hematopoietic Perifollicular Envelope in the Rat Spleen. Blood. vol. 3, pp. 953-959.

MAUN, M. E., CAHILL, W. M., and DAVIS, R. M.

1945a Morphologic Studies of Rats Deprived of Essential Amino Acids. I. Phenalalanine. Arch. Path., vol. 39, pp. 294-300.

1945b Morphologic Studies of Rats Deprived of Essential Amino Acids. II. Leucine. Ibid., vol. 40, pp. 173-178.

1946 Morphologic Studies of Rats Deprived of Essential Amino Acids. III. Histidine. Ibid., vol. 41, pp. 25-31.

MAXIMOW, A. A.

1927 Bindegewebe und Blutbildende Gewebe. Handb. d. Mikr. Anat. des Menschen. v. Möllendorff, Ed. Springer, Berlin, vol. 2, pp. 332-466.

1928 The Lymphocytes and Plasma Cells. Special Cytology. E. Cowdry, Ed. Hoeber, New York. 2nd. Ed., vol. 1, pp. 603-650.

STEWART, C. A.

1918 Changes in the Relative Weights of the Various Parts, Systems and Organs of Young Albino Rats Underfed for Various Periods. Jour. Exp. Zool., vol. 25, pp. 301-353.

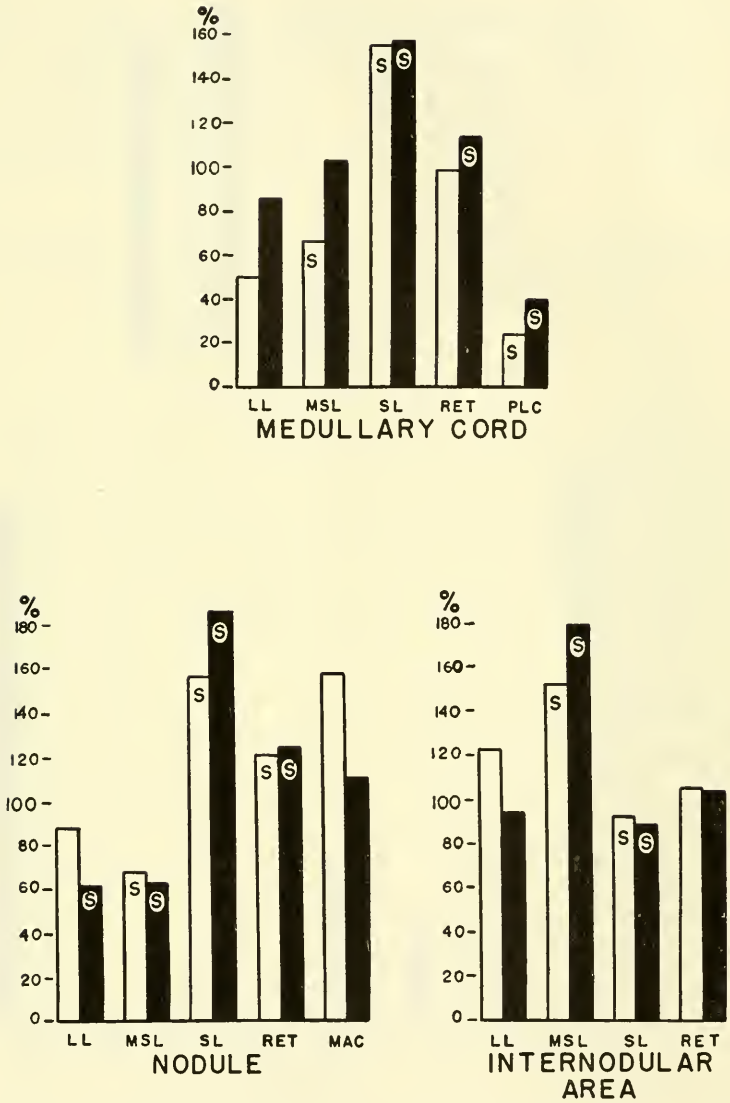


FIG. 1. Submaxillary Lymph Node. Mean number of cells per $mm^3$ expressed as a percentage of the mean normal value. Light bars, 2 percent group; dark bars, 0 percent group; S, significant difference of means; LL, large lymphocytes; MSL, medium-sized lymphocytes; SL, small lymphocytes; RET, reticular cells; MAC, macrophages; PLC, plasma cells.

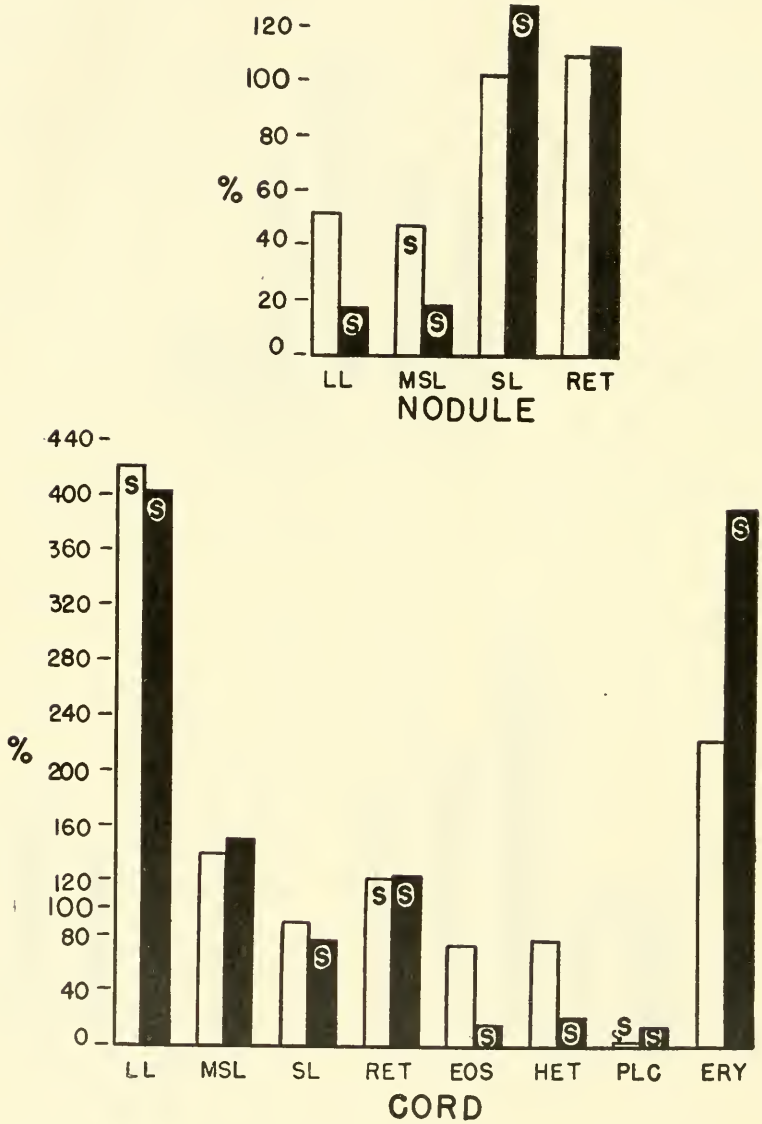


FIG. 2. Spleen. Mean number of cells per mm³ expressed as a percentage of the mean normal value. Light bars, 2 percent group; dark bars, 0 percent group; S, significant difference of means; LL, large lymphocytes; MSL, medium-sized lymphocytes; SL, small lymphocytes; RET, reticular cells; EOS, eosinophils; HET, heterophils; PLC, plasma cells; ERY, erythroid cells.

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# The Effect of Protein Deficiency on the Bone Marrow and Peripheral Blood of Young Albino Rats [1]

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Protein is one of the most important dietary constituents. A sufficient amount of an adequate protein has been shown to be necessary for growth and maintenance of the body. Therefore, many functional disorders, such as loss of weight, loss of appetite, decreased antibody formation, decreased plasma protein production as well as many others, arise as a consequence of an insufficient protein intake, a condition common in times of war, famine, and economic strife.

The effects of a protein deficient diet on peripheral blood, which have been described previously, are a lowered hemoglobin level (Orten and Smith, '37; Orten and Orten, '39; Weech *et al.*, '37; Wright and Skeggs, '46; Buechler and Guggenheim, '49), a reduced red blood cell level (Weech *et al.*, '37; Dumgent and Vermeulen, '48; Kornberg *et al.*, '46) and a granulocytopenia and leucopenia (Wright and Skeggs, '46; Kornberg *et al.*, '46; Guggenheim and Buechler, '49). In brief summary of the literature dealing with the changes in the erythrocytes and hemoglobin following specific amino acid deficiencies, it suffices to say that unless all the essential amino acids, with the possible exception of arginine, are present, normal red cell production does not occur (Benditt *et al.*, '47).

However, comparatively little is known about the cellular changes which occur in the hemopoietic organs following a dietary deficiency

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of protein. Asirvadham ('48) described the bone marrow of rats fed a 2 percent protein diet as showing a serous atrophy with a reduction of the cellular elements and a decreased proportion of myeloid cells. Several workers have made studies of the bone marrow in cases of specific amino acid deficiencies. Cartwright *et al.* ('45) described the marrow as pale and hypoplastic in tryptophane deficient swine and Glynn, Himsworth, and Neuberger ('45) reported an increase in the early erythroblast forms in the marrow of rats suffering from methionine deficiency. No alteration in the bone marrow was shown in rats fed diets deficient in either phenylalanine, leucine, histidine (Maun, Cahill, and Davis, '45a, '45b, '46, respectively), or lysine (Neuberger and Webster, '45; Gillespie, Neuberger, and Webster, '45).

The findings cited above were based on qualitative studies as far as the author could determine and no quantitative bone marrow studies have been made in regard to protein deficiency. Although quantitative investigations of the bone marrow of normal rats have been reported (to be cited later), most of the workers have recorded their counts on a percentage basis. The studies of Kindred are the exception as he also gave the total number of each cell type present in the bone marrow of young rats ('40) and data from which the number of cells per $mm^3$ of bone marrow could be calculated for young adult rats ('42). However, he reported only the total number of erythroid and myeloid cells and did not break down these general classifications into specific cell types.

Because of the paucity of information regarding the detailed cellular changes which occur in the bone marrow under conditions of general protein deficiency, the present quantitative investigation was undertaken in order to determine the specific cellular changes and their relation to the peripheral blood picture.

## MATERIALS AND METHODS

A group of rats was placed on each of the diets shown in table 1. The normal diet contained 18 percent by weight of casein, which is the amount of protein necessary for adequate growth and maintenance (Osborne and Mendel, '15). The other two diets were similar to the first in all respects except in the protien and carbohydrate content. Where the protein content was reduced to 2 percent and 0 percent, the amount of carbohydrate was correspondingly increased to make up the weight and calory discrepancy.

Upon arrival, the 22-day-old Sprague-Dawley albino rats were

weighed and tagged. They were fed the normal 18 percent protein diet for one week, at the end of which time they were divided into their respective groups. Twenty-three male and 18 female rats, which served as the normal animals, continued to receive the 18 percent protein diet (18 percent group); 27 male and 23 female rats were given the 2 percent protein diet (2% group); and 28 male and 22 female rats were fed the 0 percent protein diet (0% group).

TABLE 1. DIETS [1]

| | 18% Protein | | 2% Protein | | 0% Protein | |
|---|---|---|---|---|---|---|
| | % | Wt. / 3 Kg. | % | Wt. / 3 Kg. | % | Wt. / 3 Kg. |
| Casein | 18 | 540.0 gms. | 2 | 60.0 gms. | 0 | 0.0 gms. |
| Sucrose | 75 | 2250.0 gms. | 91 | 2730.0 gms. | 93 | 2790.0 gms. |
| Corn oil | 2 | 60.0 gms. | 2 | 60.0 gms. | 2 | 60.0 gms. |
| Salt mixture* | 4 | 120.0 gms. | 4 | 120.0 gms. | 4 | 120.0 gms. |
| Liver extract | 1 | 30.0 gms. | 1 | 30.0 gms. | 1 | 30.0 gms. |
| Choline chloride | .. | 3.0 gms. | .. | 3.0 gms. | .. | 3.0 gms. |
| Vitamin $B_1$ | .. | 16.2 mgs. | .. | 16.2 mgs. | .. | 16.2 mgs. |
| Vitamin $B_6$ | .. | 16.0 mgs. | .. | 16.0 mgs. | .. | 16.0 mgs. |
| Riboflavin | .. | 15.0 mgs. | .. | 15.0 mgs. | .. | 15.0 mgs. |
| Niacine | .. | 39.0 mgs. | .. | 39.0 mgs. | .. | 39.0 mgs. |
| Calcium pantothenate | .. | 16.0 mgs. | .. | 16.0 mgs. | .. | 16.0 mgs. |

Haliver oil ..... One drop per week, orally

Alpha tocopherol ..... One drop every 4 weeks, orally

* *Salt mixture:*

| | | | |
|---|---|---|---|
| Calcium carbonate | 200.0 gms. | Ferric ammonium citrate | 18.00 gms. |
| Potassium acid phosphate | 215.0 gms. | Potassium iodide | 0.50 gms. |
| Calcium acid phosphate | 50.0 gms. | Manganese sulphate | 3.30 gms. |
| Magnesium sulfate | 68.0 gms. | Zinc chloride | 0.16 gms. |
| Sodium chloride | 112.0 gms. | Copper sulphate | 0.20 gms. |

1. Diet recommended by Dr. R. C. Mills, Department of Biochemistry, University of Kansas.

Fifteen grams of food per rat were placed in each cage daily and the amount consumed was recorded each day. Body weights were recorded weekly.

After a period of 50 to 57 days on their respective diets, peripheral blood counts were taken on all the animals and the bone marrow, submaxillary lymph nodes, and spleens were removed for study from 11 rats of the 18 percent group, 8 of the 2 percent group and 9 of the 0 percent group. Results of the study of the submaxillary lymph nodes and spleens will be reported later.

Peripheral blood counts, using tail blood, were made in the usual manner. Three and eight-tenths percent sodium citrate was used as the diluting fluid for the platelet counts which were made in the hemocytometer counting chamber. The blood smears were stained with Wright's stain for the differential count. The hemoglobin values were determined in a Haden-Hausser hemoglobinometer. This method is rather inaccurate but it does give a general trend of the hemoglobin changes.

The bone marrow was removed from the femur in the manner described by Mayer and Ruzicka ('45), fixed in Zenker-formol solution, and embedded in paraffin. The tissues were serially sectioned at 8μ and stained with hematoxylin-eosin-azure II.

The differential cell counts were made by means of a camera lucida, as suggested by Kindred ('40, '42). A field 50μ square was calibrated on paper by means of a stage micrometer; the cells that occured in this area were sketched, counted, and classified according to type under oil immersion. Four such fields in each of twelve sections of bone marrow were studied in this manner. Thus, the cells occurring in a volume of 960,000$\mu^3$ were enumerated and the number of calls per $mm^3$ computed. This method of study was applied to the bone marrow from each rat. Since the bone marrow cells tend to localize in foci predominating in a particular cell type, the four fields were selected for counting as follows: (1) an area predominating in erythroid cells; (2) an area in which the heterophils (neutrophils) predominated; (3) an area in which many eosinophils occurred; and (4) a random area, one in which no particular cell type predominated. In almost every case, however, some cells of all types were represented in each field. The cells in the sinusoids were not included in any count. The megakaryocytes were counted in a field 500$\mu^3$ under high power in twelve sections of the bone marrow from each rat. The cells per $mm^3$ were computed from this.

The bone marrow cells were classified, according to Maximow ('27), as follows: hemocytoblast (the multipotent stem cell); reticular cell; plasma cell; basophils (which include all forms of the basophil granulocyte); megakaryocyte; promyelocyte, myelocyte, and late forms (which include the metamyelocyte and mature lobulated forms) of both the eosinophil and heterophil series; erythroblasts (which include the polychromatophil and basophil erythroblasts); and normoblasts. The granulocytes of the rat also have a form with a ring-shaped nucleus; this cell was classified with the late forms (Endicott and Ott, '45).

In this paper, the mean number of cells per $mm^3$ for each cell type in the bone marrow and peripheral blood of the protein deficient animals is expressed as a percentage of the mean normal value (that of the 18 percent group) in the accompanying figures.

The ± values in this paper represent the probable errors* of the means. In order to determine whether the mean cell counts for the protein deficient rats were significantly different from the normal means the significant ratio * was used. A value of three or greater obtained by this method is considered significant. The student's t method was also applied. When the values obtained fell in the 5 percent level or below they were considered significant.

## RESULTS

*Weights.* The rats receiving the 2 percent and 0 percent protein diets lost 34 percent and 42 percent respectively of their initial

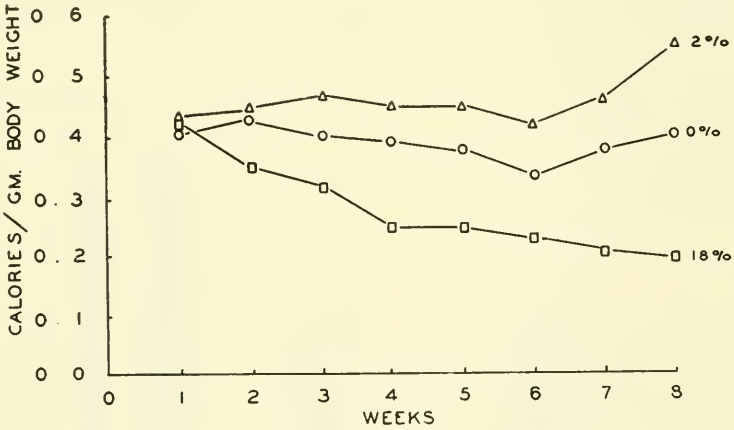


FIG. 1. Average daily caloric intake per gram of body weight.

weights by the end of the experimental period, while the normal rats (18 percent group) increased their weight by 228 percent.

*Food and caloric intake.* Although the average food intake of the protein deficient groups was less than that of the normals, it can

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* Probable error $= 0.6745 \dfrac{\delta}{\sqrt{n-1}}$

$\delta$ = standard deviation
$n$ = number of cases

* Significant ratio $= \dfrac{M_1 - M_2}{\sqrt{(P.E._1)^2 + (P.E._2)^2}}$

$M_1$ and $M_2$ = the means of the values being compared.
$P.E._1$ and $P.E._2$ = the probable errors of the means.

be seen from figure 1, that the average caloric intake per gram of body weight was greater. The implications of this will be discussed below.

*Peripheral blood.* The peripheral blood counts of the normal animals compare favorably with those reported elsewhere (Donaldson, '24; Jorden, '38; Farris and Griffith, '49). The mean values are based on the counts of both males and females since no significant difference was found between the counts of the two sexes. The erythrocytes totaled 7,770,000 ± 112,000 per $cm^3$, the leucocytes 17,600 ± 584 per $cm^3$, and the platelets 971,000 ± 26,200 per $cm^3$. The differential count showed that of the leucocytes, 79.0 ± 0.94 percent were lymphocytes, 20.0 ± 0.93 percent were heterophils, and 1.0 ± 0.25 percent were eosinophils.

As can be seen from figure 2, the number of red cells per $cm^3$ of blood was significantly decreased as a result of the protein de-

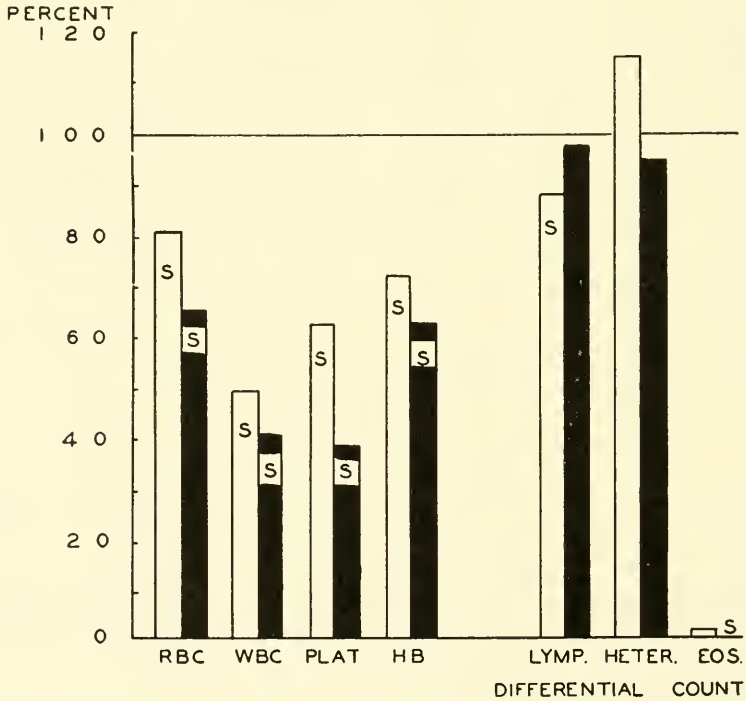


FIG. 2. Peripheral blood. Mean number of cells per $mm^3$ expressed as a percentage of the mean normal value. Light bars, 2 percent group; dark bars, 0 percent group; S, significant difference; RBC, red blood cells; WBC, white blood cells; PLAT., platelets; HB., hemoglobin; LYMP., lymphocytes; HETER., heterophils; EOS., eosinophils.

ficient diets. It is interesting that the mean erythrocyte count of the 0 percent group was significantly less than that of the 2 percent group. The total leucocyte count was also reduced in the protein deficient rats; however, there was no significant difference between the counts of the two protein deficient groups. Furthermore, there was a greater percentage decrease in the number of leucocytes than of erythrocytes.

The differential count shows that the percentage of lymphocytes was slightly decreased in the 2 percent group, whereas, the 0 percent group was essentially normal in this regard. The percentage of heterophils in the white count was not significantly affected by either of the protein deficient diets. No eosinophils appeared in the peripheral blood of any of the rats on the 0 percent diet. On the other hand, no statistically significant change occurred in the percentage of the eosinophils in the 2 percent group of rats.

The hemoglobin was well below the normal value in both groups of protein deficient rats. Since the hemoglobin levels of many of the animals in the 0 percent group fell below the lower limit of the Haden-Hausser hemoglobinometer (7.5 grams per 100 $cm^3$ of blood), the mean value shown for the group is probably higher than it actually was. Therefore, the only information the hemoglobin values convey is that they decreased; the degree of decrease is not apparent.

The platelets were decreased in number, a greater decrease occurring in the 0 percent group.

*Bone Marrow.* In table 2, which gives the normal quantitative differential counts, it can be seen that the more mature forms of the heterophil, eosinophil, and erythroid cell series occurred in greater numbers than did the younger forms. This, in general, is in agree-

TABLE 2

Differential cell count of the normal bone marrow. The values presented are the means ± the probable errors of the various cell types per $mm^3$ of tissue.

| | | | |
|---|---|---|---|
| Hemocytoblasts | 36,100 ± 2,730 | Heterophils | |
| Reticular cells | 107,000 ± 4,500 | Late forms | 645,000 ± 38,300 |
| Plasma cells | 15,900 ± 2,540 | Myelocytes | 179,000 ± 11,000 |
| Basophils | 4,520 ± 1,790 | Promyelocytes | 90,600 ± 6,230 |
| Eosinophils | | Erythroid cells | |
| Late forms | 169,000 ± 16,000 | Normoblasts | 1,770,000 ± 73,600 |
| Myelocytes | 79,500 ± 6,020 | Erythroblasts | 397,000 ± 24,700 |
| Promyelocytes | 6,720 ± 573 | Megakaryocytes | 6,030 ± 199 |

ment with the relative values reported by Stasney and Higgens ('35), Endicott and Ott ('45), Vogal ('47), Cameron and Watson ('48), and Piliero, Landau, and Gorden ('50) for the bone marrow of albino rats. In order to compare the relative numbers of total erythroid and myeloid cells present in the marrow, the myeloid/erythroid ratio was computed and found to be 0.555 ± 0.035 which is somewhat lower than those reported in the literature. The values obtained by or calculated from the figures of the investigators referred to above and Kindred ('42) range from 0.685 to 1.95. The wide variations of these figures could be due to several factors, such as the differences in the methods of obtaining the count and the strain and age differences of the animals studied.

In the rats which received the 2 percent and 0 percent protein diets (fig. 3) the numbers of hemocytoblasts and reticular cells were essentially normal. Although the mean number of basophils

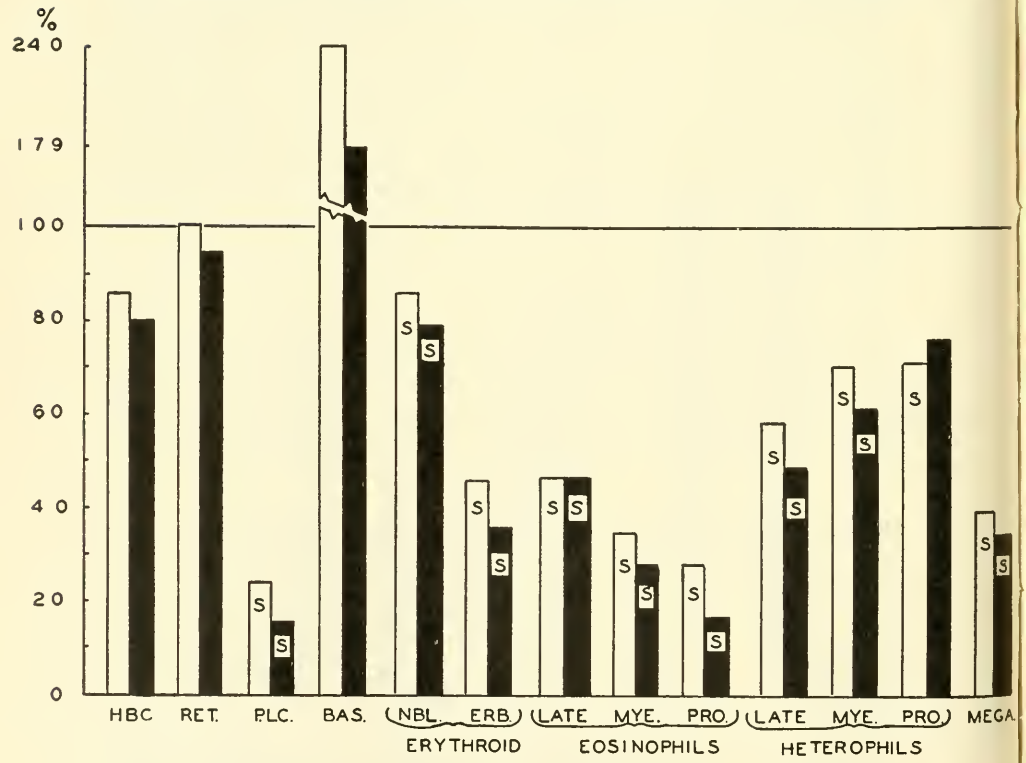


FIG. 3. Bone marrow. Mean number of cells per mm³ expressed as a percentage of the mean normal value. Light bars, 2 percent group; dark bars, 0 percent group; S, significant difference; HBC., hemocytoblast; RET., reticular cells; PLC., plasma cells; NBL., normoblasts; ERB., erythroblasts; LATE, late forms; MYE., myelocytes; PRO., promyelocytes; MEGA., megakaryocytes.

was increased above the normal level in both the protein deficient groups, the changes were not statistically significant because the number of basophils varied considerably in the individual counts. The plasma cell populations were decreased in the protein deficient rats to a greater degree than any other cell type except the promyelocyte eosinophil.

The populations of all the cells in the eosinophil, heterophil, and erythroid series were significantly decreased with the exception of the promyelocyte heterophil in the 0 percent group. Cell populations of those other than the last mentioned type were affected to approximately the same extent by both the protein deficient diets. In the eosinophil series of the protein deficient rats the number of promyelocytes were decreased to a greater extent than the myelocytes and the latter more than the late forms. In the heterophil series the reverse is true; the number of late forms was decreased to a greater degree than the myelocytes while the promyelocytes were reduced only slightly in the 2 percent group and not significantly altered in the 0 percent group. The populations of erythroblasts were decreased to a greater degree in both groups than were those of the normoblasts. Even though these relative changes occurred, the absolute number of the more mature forms still exceeded that of the younger forms in each of the three cell series in the protein deficient rats.

The number of megakaryocytes were also decreased to a significant amount in the protein deficient animals.

The myeloid/erythroid ratios for the marrow of the rats on the 2 percent and 0 percent protein diets were $0.407 \pm 0.024$ and $0.402 \pm 0.013$ respectively, both of which were significantly lower than the normal figure of $0.555 \pm 0.035$. These figures show that the numbers of myeloid cells were more greatly reduced than were the numbers of erythroid cells. This is in agreement with the findings of Asirvadham ('48). The reduced myeloid/erythroid ratio correlates with the greater reduction of leucocytes than erythrocytes.

## DISCUSSION

The results of the peripheral blood study of the rats fed the 0 percent and 2 percent protein diets are in general agreement with the reports by other workers of a decreased hemoglobin level (Orten and Smith, '37; Orten and Orten, '39; Weech *et al.*, '37; Wright and Skeggs, '46; Buechler and Guggenheim, '49), a reduced red blood cell count (Weech *et al.*, '37; Dumgent and Vermeulen, '48; Korn-

berg *et al.*, '46), and a leucopenia (Wright and Skeggs, '46; Kornberg *et al.*, '46; Guggenheim and Buechler, '49). It is difficult to make further comparison, since the degree of protein inanition and source of protein used varied considerably from the present study.

The activity of the bone marrow appears to have been greatly interferred with as a result of feeding the rats the protein deficient diets. The majority of the cell types in this organ were reduced in number; the hemocytoblast, reticular cell, basophil and heterophil promyelocyte in the 0 percent group are the exceptions. It is not surprising that the reticular cell population is unaltered because it is relatively resistant to change and is known to remain even when the other cells have almost completely disappeared as is the case after irradiation treatment (Bloom, '48). The normal hemocytoblast populations might indicate that its production and possible contribution to the formation of erythrocytes (Kindred, '42; Jorden, '39) and other bone marrow cells (Maximow, '27) were not interferred with by the deficient diets. The plasma cell was one of the most greatly affected of the cell types.

Although all the bone marrow cell types in the erythroid, eosinophil, and heterophil series, with the exception of one, were decreased, the protein deficient diets appear to have a somewhat different effect on the cells of the former two series than on those of the latter. On the one hand it was the population of the youngest cells that was decreased to the greatest extent while on the other it was the populations of the oldest cells that decreased the most. The relatively greater decrease of the erythroblasts and eosinophil promyelocyte populations might be taken to mean that their decreased production was responsible for the decreased numbers of the other bone marrow cells and the peripheral blood cells in their respective series. On the other hand, the greater decrease in the numbers of late forms of heterophils could mean that their decreased production was responsible for the reduced peripheral heterophil count. It certainly appears that whatever the mechanism may be, the protein deficiencies have resulted in a reduced peripheral blood count by affecting the development of the eosinophil and erythroid cells in one way and the development of the heterophils in another.

The production of the megakaryocyte in the bone marrow of the protein deficient rats was greatly reduced as manifested by the reduction of their numbers. This correlates with a decreased peripheral platelet count, which is to be expected since platelets are believed to be produced from the megakaryocyte ('38).

Since the food intake of the protein deficient animals was less than that of the normal animals, the observed results may be partially attributed to caloric inanition. However, when the caloric intake was computed on the basis of body weight (fig. 1), it was observed that the caloric intake per gram of body weight of the protein deficient rats was greater than of the normal animals. Thus it would appear that the changes described above were due primarily to protein deficiency.

## SUMMARY

Three groups of young albino rats were fed diets differing in protein content for a period of 50 to 57 days. One group received a normal diet containing 18 percent protein, the second one a diet containing 2 percent protein, and the third a casein free diet (0 percent protein).

The normal differential bone marrow cell count was presented giving the number of cells per $mm^3$ of tissue. The investigation of the bone marrow of the protein deficient animals showed that the populations of hemocytoblasts, reticular cells, and basophils were essentially normal. All of the cell types of the erythroid and eosinophil series were decreased in number. In the former series the erythroblasts were decreased to a greater degree than the normoblasts and in the latter series the promyelocytes and myelocytes were decreased to a greater extent than the late forms. The heterophil promyelocytes were essentially normal in the 0 percent group, while all other types of heterophils in the two groups of protein deficient rats were decreased in number. In the case of this series the late forms were decreased to a greater degree than the younger forms. The plasma cells and megakaryocytes were also decreased in number.

The depression of the populations of the progenators in the bone marrow appears to be responsible for the reduced numbers of erythrocytes, leucocytes, and platelets in the peripheral blood of these protein deficient rats. Moreover, a correlation is seen between the reduced myeloid/erythroid ratio of the bone marrow and greater reduction of leucocytes than erythrocytes in the peripheral blood. Possible interpretations of the bone marrow findings are suggested.

## LITERATURE CITED

ASIRVADHAM, M.
1948. Bone marrow and its leucocytic response in protein deficiency. Infect. Dis., *83:* 87-100.

BENDITT, E. P., E. M. HUMPHREYS, R. L. STRAUBE, R. W. WISSLER, and C. H. STEFFEE.
1947. Studies of amino acid utilization. II. Essential amino acids as sources of plasma protein and erythrocytes in the hypoproteinemic rat. Journ. Nutrition, *33:* 85-94.

BLOOM, M. A.
1948. Bone marrow. In Histopathology of Irradiation from External and Internal Sources. Ed. by W. Bloom, McGraw-Hill Book Co., New York. Chap. 6, 162-242.

BUECHLER, E., and K. GUGGENHEIM.
1949. The effect of quantitative and qualitative protein deficiency on blood regeneration. II. Hemoglobin. Blood, *4:* 964-969.

CAMERON, D. G., and C. M. WATSON.
1948. Femoral bone marrow biopsy in the albino rat. Blood, *3:* 292-294.

CARTWRIGHT, G. E., M. M. WINTHROBE, W. H. BUSCHKE, R. H. FOLLIS, JR., A. SUKSTRA, and S. HUMPHREYS.
1945. Anemia, Hypoproteinemia and cataracts in swine fed casein hydrolysate or zein. Comparison with pyrodoxine deficiency anemia. Journ. Clin. Invest., *24:* 268-277.

DONALDSON, H. H.
1924. The Rat. Wistar Institute, Philadelphia.

DUMGENT, C., and M. VERMEULEN.
1947. Sur l' anemia provoques chez le rat par l' inanition proteinque. C. R. Soc. Biol., *141:* 292-294. (From Nutrit. Abst. and Rev., *17:* 685, 1948).

ENDICOTT, K. M., and M. OTT.
1945. The normal myelogram in albino rats. Anat. Rec., *92:* 61-69.

FARRIS, E. J., and J. G. GRIFFITH.
1949. The Rat in Laboratory Investigation. 2nd. ed., Lippincott Co., Philadelphia.

GILLESPIE, M., A. NEUBERGER, and T. A. WEBSTER.
1945. Further studies of lysine deficiency in rats. Bio. Chem. Journ., *39:* 203-208.

GLYNN, L. E., H. P. HIMSWORTH, and A. NEUBERGER.
1945. Pathological states due to deficiencies of sulphur-containing amino acids. Brit. Journ. Exp. Path., *26:* 326-337.

GUGGENHEIM, K., and E. BUECHLER.
1949. The effect of quantitative and qualitative protein deficiency on blood regeneration. I. White cells. Blood, *4:* 958-963.

JORDEN, H. E.
1938. Comparative hematology. In Handbook of Hematology. Ed. by H. Downey, Paul B. Hoeber, Inc., New York. Vol. 1, 703-862.
1939. The lymphocytes in relation to erythrocyte production. Anat. Rec., *73:* 227-241.

Kindred, J. E.
1940. A quantitative study of the hemopoietic organs of young albino rats. Amer. Journ. Anat., *67:* 99-149.
1942. A quantitative study of the hemopoietic organs of young adult albino rats. Amer. Journ. Anat., *71:* 207-243.

Kornberg, A., F. S. Draft, and W. H. Sebrell.
1946. Granulocytopenia and anemia in rats fed diets of low casein content. Science, *103:* 646-648.

Maun, M. E., W. M. Cahill and R. M. Davis.
1945a. Morphologic studies of rats deprived of essential amino acids. I. Phenalalanine. Arch. Path., 39: 294-300.
1945b. Morphologic studies of rats deprived of essential amino acids. II. Leucine. Arch. Path., 40: 173-178.
1946. Morphologic studies of rats deprived of essential amino acids. III. Histidine. Arch. Path., 41: 25-31.

Maximow, A. A.
1927. Bindegewebe und blutbildende Gewebe. In Handbuck der Mikroscopischen Anatomie des Menschen. Ed. by W. von Mollendorf. Julius Springer, Berlin. Pt. 1, 332-466.

Mayer, E., and A. Q. Ruzicka.
1945. A method for studying numerical and topographic problems in the whole femoral marrow of rats and guinea pigs, with the use of undecalcified sections. Anat. Rec., *93:* 213-231.

Neuberger, A. and T. A. Webster.
1945. Lysine requirements of the adult rat. Biochem. Journ., *39:* 200-202.

Orten, A. U., and A. H. Smith.
1937. The effect of dietary protein on endocrine function and on the blood picture in female rats. Amer. Journ. Physiol., *119:* 381-382.

Orten, J. M., and A. U. Orten.
1939. The relation of dietary protein to hemoglobin formation in the rat. Journ. Biol. Chem., *128:* LXXVII.

Osborne, T. B., and L. B. Mendel.
1915. The comparative nutritive value of certain proteins in growth, and the problem of the protein minimum. Journ. Biol. Chem., *20:* 351-378.

Piliero, S. J., D. Landau, and A. S. Gorden.
1950. Adrenal gland and hemopoiesis. Science, *112:* 559-560.

Rosenthal, N.
1938. Blood platelets and megakaryocytes. In Handbook of Hematology. Ed. by H. Downey, Paul B. Hoeber, Inc., New York. Vol. 1, 448-496.

Stasney, J., and G. M. Higgens.
1935. A quantitative cytological study of the bone marrow of the adult albino rat. Anat. Rec., *63:* 77-89.

Vogel, M.
1947. The femoral bone marrow cells of the albino rat. Amer. Journ. M. Sce., *213:* 456-462.

WEECH, A. A., M. WOLLSTEIN, and E. GOETTSCH.
1937. Nutritional edema in the dog. V. Development of deficits in erythrocyte and hemoglobin on a diet deficient in protein. Journ. Clin. Invest., *16:* 719-728.

WRIGHT, L. L., and H. R. SKEGGS.
1946. Vitamin B complex studies with diets deficient in level of protein. Proc. Soc. Exp. Biol. Med., *63:* 327-333.

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# Biological and Systematic Studies on the Subgenus *Neotrombicula* (Genus *Trombicula*) in the Central United States (Acarina, Trombiculidae) *

By

ERVIN H. KARDOS

ABSTRACT: This paper consists of studies of larval chigger mites of the subgenus *Neotrombicula* from the central United States. A key to all species known in this country is included, and two new species are described. *Trombicula* (*Neotrombicula*) *autumnalis*, hitherto known from Europe, is recorded from America for the first time.

Long series of specimens were examined whenever possible and considerable data on variations within populations and on geographical variations are presented. This is particularly important since much of the previous work on chiggers has been done with very inadequate series of specimens even when long series were available. *T. microti* and *T. harperi* were found to behave as distinct species even though so similar that a few specimens could not be placed with certainty in one species or the other. *T. lipovskyi* and *T. whartoni* were also found to be distinct sympatric species although very closely related. Certain characters which distinguish them in one area are of little value in another area where other characters are more useful. *T. whartoni* is restricted to moist, usually woodland areas while *T. lipovskyi* is found both in such areas and in dry treeless regions.

Data on hosts and seasonal activity are provided for each species treated. Some of the other ecological requirements can often be inferred from the places where host animals were obtained and are presented whenever pertinent. Further biological data is provided for certain species, particularly *T. lipovskyi* and *T. sylvilagi*. Like other species of *Neotrombicula* occurring in the Kansas region, these forms are active as larvae in fall and winter. Larvae of the first are abundant in Kansas from October through December, become scarce in late December, January, and February, and show a lesser peak of activity again in March and April. Larvae of *T. sylvilagi* are active in the same area from the last half of August to the first half of December. Both species, and perhaps all "winter chiggers," have but one generation per year, in contrast to at least some of the forms whose larvae are active in summer (*e. g.*, *T. alfreddugèsi*). In *T. lipovskyi* engorged larvae dropping from hosts in November became nymphs under outdoor temperatures from April to July and the first adults appeared in late June.

* Contribution number 838 from the Department of Entomology, University of Kansas.

## INTRODUCTION

This paper comprises taxonomic, ecological, and biological studies on the known chiggers of the subgenus *Neotrombicula* Hirst from the states of Utah, Wyoming, Colorado, Nebraska, Kansas, Oklahoma, Missouri, and Arkansas. Material from other areas was examined for comparison. The taxonomic studies of larvae were based almost entirely on specimens in the University of Kansas Snow Entomological Museum. In the descriptions of new species, the description is based on the holotype with differences occurring in the paratypes indicated in parentheses. Under the heading, additional records, is included information on previously published records from the states concerned. All scutal measurements are included in table 8. The terminology used in this paper follows that proposed by Wharton *et al* (1951). The ecological and biological studies were largely confined to those species occurring in northeastern Kansas (particularly Douglas County), although host and habitat data are provided for other areas.

The larval chiggers of the subgenus *Neotrombicula* were taken only from birds and mammals although many reptiles have been examined from areas where *Neotrombicula* is common. These hosts were obtained by shooting, in the case of birds and larger mammals, and snap or live trapping for smaller mammals. Each specimen (or specimens) of each species from each locality was assigned a field number which correlates it with all recorded data. The birds and mammals were placed according to field number into separate bags. In the laboratory the bags were placed in the refrigerator and kept there at approximately 40° F. from one to several days. The animals were then removed, usually examined to determine the location of the chiggers, and warmed at room temperature for one to two hours. Following this they were washed two or three times in a solution of synthetic detergent and water. The solution was then decanted. The residue was examined under a dissecting microscope and the larval chiggers were recovered and sorted. The animals were always examined after washing, particularly in the ears, to find and recover any remaining chiggers. This washing method is discussed in detail by Lipovsky (1951b). However, some hosts, particularly those from the Rocky Mountain region, were superficially examined and the chiggers were removed and preserved in the field. Mammals which were live-trapped were placed in screen cages over pans containing a synthetic detergent in water, which caught the fully engorged chiggers as they dropped

from the host. After recording the numbers and kinds recovered from each host, the chiggers were either preserved in from 75 to 85 percent ethyl alcohol or were reared.

The number of each species of chigger from each host was determined either immediately after removal from the hosts or after preservation. When only a few chiggers were recovered they were all mounted. However, whenever larger numbers were recovered, the *Neotrombicula* were separated from the other genera and subgenera by characters seen with the aid of a dissecting microscope at 96 power. The color of the living *Neotrombicula* was usually red (unengorged) to relatively bright orange (engorged). One specimen of *Trombicula whartoni*, however, was bright yellow. This character cannot be used with preserved specimens as they lose their color. The other characters visible with a dissecting microscope include the relative size and body shape, the flagelliform sensilla, the five scutal setae, the long nude setae on leg III, and the relatively longer and fewer body setae (especially when compared to the *Euschöngastia* of northeastern Kansas). The number of each species of *Neotrombicula* was estimated by mounting approximately 20 representatives.

The specimens examined in the University of Kansas Snow Entomological Museum (listed as KU, with the slide number) were mounted in a mixture of polyvinyl alcohol and lacto-phenol (PVA-LP) as described by Lipovsky (1953b).

A phase contrast microscope was used for all measurements and other detailed microscopic work. The illustrations were made with the aid of a camera lucida. Whenever possible, scutal measurements were made on unengorged or slightly engorged specimens.

## ACKNOWLEDGMENTS

The studies upon which this paper is based were conducted under a contract, N6 ori-220, Task Order II, between the University of Kansas and the Office of Naval Research. Particularly useful were the excellent laboratory facilities and extensive chigger collections built up in considerable part by Mr. Louis J. Lipovsky, at the University of Kansas.

The majority of the hosts of *Neotrombicula* larvae were collected and identified by Mr. Robert B. Finley, Jr., and Mr. Richard B. Loomis, while other hosts were taken by Mr. L. J. Lipovsky and other members of the chigger project as well as staff members and graduate students in the Departments of Entomology and Zoology at the University of Kansas. Dr. Cluff Hopla of the University of

Oklahoma, Department of Zoological Sciences, generously supplied us with the Utah chiggers, and many of the Oklahoma hosts.

Thanks are also extended to Dr. Henry S. Fitch for permission to carry on the ecological studies at the University of Kansas Natural History Reservation.

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My sincere gratitude is extended to Mr. Richard B. Loomis and Dr. Charles D. Michener for many helpful suggestions and valuable criticisms during the study and the preparation of this paper.

## SYSTEMATIC AND BIOLOGICAL ACCOUNT

### Subgenus NEOTROMBICULA Hirst

*Neotrombicula* Hirst, 1925, Nature, vol. 116, p. 609.
Type of subgenus: *Acarus autumnalis* Shaw, 1790.

The subgenus *Neotrombicula* includes all species of *Trombicula* having the following larval characters: more or less pentagonal scutum; leg III with one or more mastitarsalae, tibia and telofemur III with long nude (mastitibiala and mastifemorala III) or long plumose setae; a single feathered seta present on each coxa; sternal setae arranged 2-2; palpal claw with three prongs.

Brennan and Wharton (1950:156) separated *Neotrombicula* into several groups based on the number and arrangement of the long nude setae on leg III; these are the "autumnalis" group, the "microti" group, the "bisignata" group, and the remaining ungrouped species. The characteristics of these groups are given in table 1.

TABLE 1

Characteristics of the Groups of *Neotrombicula*

| | Autumnalis group | Bisignata group | Microti group | Ungrouped species | | |
|---|---|---|---|---|---|---|
| mastitarsala III | 1 | 3 | 2 | 2 | 2 | 3 |
| mastitibiala[1] III | 0 | 1 | 1 | 1 | 2 | 1 |
| mastifemorala[1] III | 0 | 0 | 1[2] | 0 | 0 | 1 |

1. In the cases where there are no mastifemorala or mastitibiala III present there are long plumose setae in their places.

2. Basal barbs are occasionally present on the mastifemorala III of *californica*, *goodpasteri*, and *richmondi*.

## KEYS TO THE NEOTROMBICULA OF THE UNITED STATES [3]

(Modified from Brennan and Wharton, 1950)

### autumnalis group

Only one species known in the United States ..... *autumnalis* *

### bisignata group

1. Seta on palpal femur nude ..... *eusignata*
   Seta on palpal femur branched or feathered ..... 2
2. Seta on palpal genu nude; first dorsal posthumeral row usually with six (occasionally seven) setae ..... *subsignata* *
   Seta on palpal genu branched; first posthumeral row usually with eight (occasionally seven) setae ..... *bisignata*

### microti group

1. Leg I with three genualae ..... *dinehartae*
   Leg I with one or two genualae ..... 2
2. Seta on palpal genu nude, on femur usually nude ..... 3
   Seta on palpal genu and on femur branched or feathered ..... 6
3. Sensilla nude; seta on palpal femur nude or branched ..... *californica*
   Sensilla with at least minute barbs; seta on palpal femur nude ..... 4
4. Sensilla with minute basal barbs; first posthumeral row with 10 to 14 setae; dorsal setae more than 40 ..... *browni* *
   Sensilla with pronounced barbs along most of its length; six to nine (rarely ten or eleven) setae in the first posthumeral row; dorsal setae less than 40 ..... 5
5. Galeal seta nude, occasionally one with a single branch. Usually with eight or nine setae in the first posthumeral row ..... *harperi* *
   Galeal seta with one to several branches. Usually with six setae in the first posthumeral row ..... *microti* *
6. Galeal seta branched ..... 7
   Galeal seta nude ..... 10
7. Sensilla with several pronounced apical branches ..... *loomisi* *
   Sensilla nude or with barbs, never with only pronounced apical branches ..... 8
8. Scutum distinctly flattened posteriorly; sensilla nude or with indistinct basal barbs ..... *cavicola*
   Scutum usually rounded posteriorly; sensilla with distinct barbs present ..... 9
9. Sensilla with short barbs on basal half only; ratio of posterolateral seta (PL) to anterolateral seta (AL) of scutum, .6 to .8 ..... *jewetti*
   Sensilla with pronounced barbs along most of its length; ratio PL to AL .9 ..... *finleyi* *
10. Leg I with one genuala ..... *richmondi* *
    Leg I with two genualae ..... 11
11. Humeral setae total three or more ..... *goodpasteri*
    Humeral setae total two ..... 12

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3. Species discussed in this paper are marked with an asterisk.

12. Scutum with few and scattered punctae, posterior margin angular; sensilla usually with few minute basal barbs. (Scutal punctae more numerous and sensillae with pronounced barbs on basal half in Arkansas and Mississippi specimens, as shown in figures 19-22.), *whartoni* *

Scutum with numerous and evenly distributed punctae, posterior margin broadly rounded; sensilla with pronounced barbs along most of its length . . . . . *lipovskyi* *

Ungrouped Species

1. Seta on palpal femur and on genu nude; leg I with three genualae; two mastitibialae III present . . . . . *sylvilagi* *

Seta on palpal femur and on genu feathered; leg I with one or two genualae; one mastitibiala III present . . . . . 2

2. Galeal seta branched; leg III with mastifemorala . . . . . *varians*

Galeal seta nude; leg III without mastifemorala . . . . . 3

3. Leg I with two genualae; lateral seta on palpal tibia nude . . *waynensis*

Leg I with one genuala; lateral seta on palpal tibia feathered . . . . . 4

4. Dorsal setal formula beginning 4-4 . . . . . *farrelli* [4]

Dorsal setal formula beginning 2-6 . . . . . *carterae* [4]

## AUTUMNALIS GROUP

The "autumnalis" group is regarded by the writer to be restricted to those species of *Neotrombicula* that have only a single long, nude seta (mastitarsala) on leg III. The only species of this group known from North America is *T. autumnalis,* or a form whose larvae seem indistinguishable from it. It is here recorded from the Western Hemisphere for the first time. *T. autumnalis* is otherwise known only from Europe, and does not seem to occur in eastern Asia. Its appearance in North America is therefore most surprising.

### *Trombicula* (*Neotrombicula*) *autumnalis* (Shaw)

Figures 3-6. Tables 4 and 8.

*Acarus autumnalis* Shaw, 1790, Nat. Misc., vol. 2, p. 42.
*Trombicula autumnalis,* Kneissl, 1916, Zool. Anz., vol. 46, p. 253; Richards, 1950, Parasitology, vol. 40, pp. 105-117, "lectotype" [= neotype], Birkshire, England, Fair Mile, Warren Farm, Streatley, Oct. 2, 1946, British Museum (Natural History).
*Trombicula* (*Neotrombicula*) *autumnale,* Hirst, 1925, Nature, vol. 116, p. 609.
*Trombicula* (*Neotrombicula*) *autumnalis,* Hirst, 1926, Ann. Appl. Biol., vol. 13, pp. 140-143. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, pp. 56-58 (includes a comprehensive synonymy).

*Diagnosis.* Based on the American specimens. A member of the "autumnalis" group with the following larval characters: palpal femur with feathered seta, genual and ventral tibial setae branched, both dorsal and lateral tibial setae nude; three genualae I; six setae present in each of first and second posthumeral rows.

4. The writer questions the validity of the basis of the separation of the two species.

*Geographic range.* This species is known from Europe (see Wharton and Fuller, 1952:56-57) and North America; southwestern Colorado (Dolores County) and southwestern Nebraska (Dundy County).

*Seasonal occurrence.* North America: Colorado, Oct. 18; Nebraska, Nov. 1.

The following is a description of the American specimens.

*Body.* Unengorged or slightly engorged specimen (KU 5803), length 304 μ, width 197 μ. Eyes two on each side, subequal. Color in life deep red (Nebraska specimens).

*Gnathosoma.* Palpal coxa with feathered seta; femur with dorsal feathered seta; genu with dorsal branched seta; tibia with dorsal and lateral setae nude, ventral seta branched; tarsus with spur, subterminala, single robust feathered dorsal and six feathered ventral setae. Galeal seta nude.

*Legs.* Leg I: coxa, trochanter, basifemur with one feathered seta each; telofemur with five feathered setae; genu with three genualae, microgenuala, and four feathered setae; tibia with two tibialae, microtibiala, and eight feathered setae; tarsus with spur, microspur, parasubterminala, subterminala, pretarsala, and approximately twenty feathered setae. Leg II: coxa and trochanter with one feathered seta each; basifemur with two feathered setae; telofemur with four feathered setae; genu with one genuala and three feathered setae; tibia with two tibialae and six feathered setae; tarsus with microspur, spur, pretarsala, and approximately fifteen feathered setae. Leg III: coxa and trochanter with one feathered seta each; basifemur with two feathered setae; telofemur with three feathered setae (inclusive of the long plumose seta as shown in fig. 6); genu with genuala and three feathered setae; tibia with tibiala and six feathered setae (includes the long plumose seta as in fig. 6); tarsus with mastitarsala and approximately thirteen feathered setae.

*Scutum.* Posterior angle rounded. Punctae small, numerous, evenly distributed. Sensillary bases anterior to the bases of anterolateral setae. Sensillae of Nebraska specimens with approximately six to nine distinct branches on the apical two thirds; Colorado specimen with seven shorter branches on an apical fragment (fig. 3). For scutal measurements see table 8.

*Setae.* Dorsal body setal formula of ten specimens from Nebraska 2-6-6 + 22 to 29 (mean 27), one specimen from Colorado 2-6-6 +

25; ventral setae, from Nebraska 2-2-30 to 38 (mean 34), from Colorado, 2-2-34; total body setae, Nebraska 74-84, Colorado 77.

*Remarks.* The larval specimens from America are indistinguishable from the specimens examined from England. On the basis of Richard's key (1950a:116) for separating the "five main types of harvest mite larvae found in Great Britain" the American specimens would be classified as "normal type b." Furthermore, the American specimens are similar to Richard's (1950a:116) description of the lectotype [=neotype] in having a simple galeal seta, a single pair of humeral setae, and six setae in the first and second posthumeral rows.

The sensillary branches of the specimens from Nebraska (fig. 4) are elongate, similar to the English specimens, while the apical fragment of a Colorado specimen (fig. 3) indicates more numerous but shorter branches. On the basis of the larval characters studied, these specimens are considered to be *T. autumnalis.* However, it is possible that differences between the European and American forms may be found in other stages.

Richards (1950a and b) reported the variations occurring in what he defines as *T. autumnalis,* in Great Britain. After examining the data presented by Richards, I am in agreement with Womersley (1952:365) who stated that ". . . some of the variations suggest that at least two species occur in Britain."

*Ecology.* In Dundy County, Nebraska, Richard B. Loomis reports that the hosts were trapped along Rock Creek in isolated wet meadows, which are fed by continuously flowing springs. These meadows are situated in or adjacent to a tall grass marshy habitat, in strong contrast to the dispersed clumps of short grasses and yucca on the very dry sandy soil surrounding the valley. A few willows were situated near the meadows along the creek.

Most of the specimens of *T. autumnalis* from hosts collected in Dundy County, Nebraska, were found in the ears. Only seven of the 68 specimens were partially or fully engorged. The large number of unengorged and slightly engorged *autumnalis* indicates that the collection date, November 1, 1952, was early in the season and strongly suggests that this is a fall and winter chigger in this locality.

In Dolores County, Colorado, R. B. Finley, Jr. reports that the nest of the host, *Neotoma cinerea,* was situated among rocks within open woods. The trees were primarily aspen with scattered western yellow pines (*Pinus ponderosa*). The principal shrubbery within 100 feet of the nest (the approximate range of *Neotoma* from the

nest, according to Finley) included scrub oak (*Quercus gambellii*), choke cherry (*Prunus virginianus*), serviceberry (*Amelanchier* sp.) and *Galium* sp. Approximately 100 feet from the nest was a hollow characterized by a moist, dark loam soil; irises were present in the hollow. The whole area was moderately shaded.

*Specimens examined.* Total number 72, as follows: COLORADO—*Dolores County:* 15 mi. N, 10 mi. E Dolores, *Neotoma cinerea,* Oct. 18, 1949, KU 4003-4. NEBRASKA—*Dundy County:* 5 mi. N, 2 mi. W Parks, Rock Creek Fish Hatchery, *Microtus ochrogaster,* KU 5821-75—*Microtus pennsylvanicus,* KU 5809-20—*Reithrodontomys megalotis,* KU 5808, all collected Nov. 1, 1952. GREAT BRITAIN—*Skomer Island:* Pembrokershire, *Puffinus puffinus,* Sept. 14, 1947, 1. *Wales:* Guilsfield without Montgomeryshire, *Oryctolagus cuniculus,* 1.

## BISIGNATA GROUP

This group is represented in North America by three species only, of which only *T. subsignata* is known from the states included in this paper.

### *Trombicula* (*Neotrombicula*) *subsignata* Brennan and Wharton

Tables 4 and 8

*Trombicula* (*Neotrombicula*) *subsignata* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 159-161, type: USNM no. 1837, Broome Co., N. Y., *Microtus pennsylvanicus,* Aug. 10, 1947. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 60.

*Diagnosis.* A member of the "bisignata" group with the larval characters as follows: palpal femoral seta branched, genual and dorsal tibial setae nude; first posthumeral row usually with six, occasionally with seven setae.

*Geographic range.* This species is known from Montana (Ravalli County) south to Colorado (Boulder County); North Dakota (Morton County); Missouri (Taney County); Pennsylvania (Wayne and Warren Counties) to New York (Broome County).

*Seasonal occurrence.* In the Rocky Mountain region the earliest record of this species is June 12 (Ravalli County, Montana, Brennan and Wharton, 1950:161); the latest record is August 15 (Boulder County, Colorado).

*Remarks.* Of five specimens examined from Boulder County, Colorado, one (KU 4141) had both palpal genual setae forked, another (KU 4143) had only one forked, the other three (as well as the specimens examined from the other areas) had both setae nude. Six setae were seen in the first posthumeral row in all but

three of the specimens examined; the specimen from Carbon County, Wyoming had seven setae, while two specimens from Boulder County, Colorado had this character obscure.

*Specimens examined.* Total number 9, as follows: WYOMING—*Carbon County:* Bridger's Pass, 18 mi. SW Rawlins, 7500 ft., *Zapus princeps,* July 24, 1947, KU 4138. COLORADO—*Boulder County:* 12½ mi. E Estes Park, 8400 ft., KU 4139-40; 1 mi. SE Ward, KU 4141-43; 3 mi. NE Nederland, KU 4144; all from *Citellus lateralis,* collected August 6-15, 1947. MISSOURI—*Taney County:* 1½ mi. SW Forsyth, *Capella gallinago,* Sept. 7, 1947, KU 4025. NEW YORK—*Broome County:* 6 mi. N Binghamton, *Microtus pennsylvanicus,* Aug. 10, 1947, KU 4145 (Topotype).

### MICROTI GROUP

This is the largest group of the subgenus, containing fourteen species in North America. With the exception of three, species of this group have two humeral setae and two genualae I. The three species are *T. goodpasteri,* which has more than two humeral setae, *T. richmondi,* with a single genuala I, and *T. dinehartae,* which, according to Brennan and Wharton (1950:179), has three genualae I. Of the fourteen species, eight are known from the states included in this paper.

### *Trombicula* (*Neotrombicula*) *microti* Ewing

Tables 3-4, 8-9

*Trombicula microti* Ewing, 1928, Proc. Ent. Soc. Washington, vol. 30, no. 5, p. 80, type; USNM no. 984, Lincoln Co., Wyo., Gravel Creek, tributary of Pacific Creek, *Microtus richardsoni macropus,* Aug. 13, 1927, coll. O. J. Murie; 1931, Proc. U. S. Nat. Mus., vol. 80, Art. 8, p. 9; 1937, Proc. Biol. Soc. Washington, vol. 50, p. 171. Radford, 1942, Parasit., vol. 34, p. 57. Wharton, 1946, Proc. Ent. Soc. Washington, vol. 48, p. 176. Michener, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 431. Thor and Willmann, 1947, Das Tierreich, lief. 71b, p. 268. Philip and Fuller, 1950, Parasitology, vol. 40, p. 56.

*Trombicula parkeri* Radford, 1942, Parasitology, vol. 34, p. 62, type; Conejos Co., Colo., Antonito, *Ochotona princeps* or Cony, Sept. 9, 1930, British Museum (Natural History); 1946, Proc. Zool. Soc. London, vol. 116, p. 587; 1947, Proc. Zool. Soc. London, vol. 117, p. 275. Michener, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 432. Philip and Fuller, 1950, Parasitology, vol. 40, p. 56. Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, pp. 167-168.

*Trombicula* (*Neotrombicula*) *microti,* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 164-169. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 59.

*Diagnosis.* A member of the "microti" group with the larval characters as follows: seta on palpal femur and on genu nude; both galeal setae with one or more branches; first posthumeral row usually with six (occasionally seven) setae, less than 40 dorsal body setae; sensilla with pronounced barbs on the apical two thirds.

*Geographic range.* This species is known from the Pacific coastal states of Washington (King County) south to California (Mono County); in the Rocky Mountain region from Alberta (Edmonton), Canada south to New Mexico (Catron County); in the east from Pennsylvania (Wayne and Monroe counties) north through eastern Canada to Labrador (Goose Bay).

*Seasonal occurrence.* In the Rocky Mountain region this species has been taken as early as July 19 (San Juan County, Colorado), and as late as October 25 (Ravalli County, Montana, Brennan and Wharton, 1950:166).

*Remarks.* The specimens of *T. microti* examined had both galeal setae branched at least once, usually twice or more.

The first posthumeral row had six setae in 18 of 19 specimens from Wyoming and Colorado, and 35 of 40 specimens examined from Utah; the others possessed seven setae.

The parasubterminalae were both nude and branched. Eleven of thirteen specimens from Colorado and Wyoming had setae nude, while each of the other two had a single branched parasubterminala. Fourteen of 24 Utah specimens had one parasubterminala branched, nine had both nude, and one had both branched.

*Specimens examined.* Total number 98, as follows: MONTANA—*Ravalli County: Neotoma* sp., KU 4112—*Tamiasciurus* sp., KU 4113, all collected Aug. 12 and 17, 1945. WYOMING—*Carbon County:* Bridger's Pass, 18 mi. SW Rawlins, 7500 ft., *Microtus longicaudus,* KU 4122-24—*Microtus montanus,* KU 4119-20—*Phenacomys intermedius,* KU 4022, 4115-17—*Zapus princeps,* KU 4114, 4118, all collected July 23-25, 1947. UTAH—*Summit County:* Uinta Mts., Boulder Mt., 10,900 ft., *Ochotona princeps,* Aug. 2, 1952, KU 4032-4100. COLORADO—*Rio Blanco County:* 5 mi. S Pagoda Peak, 9100 ft., *Microtus* sp., July 28, 1947, KU 4126-27; 1 mi. NW Pagoda Peak, 10,400 ft., *Ochotona princeps,* July 28, 1947, KU 4125, 4128-29, 4397. *Gunnison County:* 3 mi. S, 6½ mi. E Crested Butte, 9200 ft., *Neotoma cinerea,* Aug. 10, 1948, KU 4013, 4131-33, 4135. *San Juan County:* 6½ mi. SW Silverton, 10,100 ft., *Neotoma cinerea,* July 19, 1949, KU 4136. PENNSYLVANIA—*Monroe County: Pitymys* sp., Sept. 13, 1949, 2, Duke Univ. MAINE—*Cumberland County:* Brunswick, *Tamiasciurus hudsonicus,* Sept. 21, 1951, KU 4137. CANADA—*Ontario:* Quetico, *Clethrionomys gapperi,* July, 1933, KU 4026.

*Additional records.* Brennan and Wharton (1950:166-167): WYOMING—*Lincoln County: Microtus richardsoni,* August 13, 1927, type specimen. *Albany County: Ochotona princeps,* Aug. 29, 1946,

2. COLORADO—Rocky Mt. Natl. Park, *Microtus* sp., Sept. 8, 1948. *Conejos County: Ochotona princeps,* Sept. 9, 1931.

### *Trombicula* (*Neotrombicula*) *harperi* Ewing

Tables 2-4, 8-9

*Trombicula harperi* Ewing, 1928, Proc. Ent. Soc. Washington, vol. 30, no. 5, p. 79, type: USNM no. 983, Essex County, N. Y., Heart Lake, *Napeozapus insignis,* Summer, 1926, coll. F. Harper; 1931, Proc. U. S. Nat. Mus., vol. 80, art. 8, p. 8. Philip and Fuller, 1950, Parasitology, vol. 40, p. 56.

*Eutrombicula harperi,* Ewing, 1938, Jour. Washington Acad. Sci., vol. 28, p. 294. Radford, 1942, Parasitology, vol. 34, p. 67. Knight, 1951, Canad. Ent., vol. 83, no. 10, pp. 279-280.

*Trombicula* (*Eutrombicula*) *harperi,* Thor and Willmann, 1947, Das Tierreich, lief. 71b, p. 285.

*Trombicula* (*Neotrombicula*) *harperi,* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, pp. 170-172. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 58.

*Diagnosis.* A member of the "microti" group with the larval characters as follows: seta on the palpal femur and on genu nude; galeal setae nude (occasionally one with a single branch); usually eight or nine setae in the first posthumeral row, less than 40 dorsal body setae; sensilla with pronounced barbs along most of its length.

*Geographic range.* This species is known from British Columbia, (Vancouver, Knight, 1951); the Rocky Mountain region from Montana (Missoula County) and Idaho (Lemhi County) to Wyoming (Washakie County) and Colorado (La Plata and Conejos counties); and in the east from Pennsylvania (Beaver and Monroe counties) to Maine (Piscataquis County).

*Seasonal occurrence.* In the Rocky Mountain region this species has been taken as early as June 11 and as late as August 20 (both records from Ravalli County, Montana, Brennan and Wharton, 1950:171).

*Remarks.* Among the specimens of *T. harperi* examined, the galeal setae were normally nude, however, 21 specimens had a single branch occurring on one seta. Usually the larvae had one or both parasubterminalae branched. The variation in the number of setae of the first posthumeral row is summarized in Table 2.

Some of the anomalous characters occurring on the specimens examined are as follows: Two specimens had a duplication of the anteromedian scutal seta (AM); on one specimen (KU 4391, Rio Blanco County, Colorado) the AM's were arranged laterally, on the other (KU 4586, San Juan County, Colorado) they were arranged medially. A single specimen (KU 4437, Boulder County, Colorado) had three mastitarsalae III on one leg, while the other leg had the normal number of two, and a single specimen (KU 4569, San Juan

TABLE 2

The Number of Setae in the First Posthumeral Row of *T. harperi*

| | 7 | | 8 | | 9 | | 10 | | 11 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. spec. | Pct. of series | No. spec. | Pct. of series | No. spec. | Pct. of series | No. spec. | Pct. of series | No. spec. | Pct. of series |
| Washakie County, Wyo. | 1 | 2% | 45 | 68% | 19 | 29% | 1 | 2% | ..... | % |
| Carbon County, Wyo. | 1 | 2 | 43 | 65 | 17 | 26 | 4 | 6 | 1 | 2 |
| Rio Blanco County, Colo. | ..... | ..... | 37 | 62 | 18 | 30 | 5 | 8 | ..... | ..... |
| Boulder County, Colo. | 5 | 4 | 106 | 83 | 15 | 12 | 2 | 2 | 1 | 1 |
| San Juan County, Colo. | 3 | 7 | 30 | 65 | 10 | 22 | 3 | 7 | ..... | ..... |
| Total | 10 | 4 | 261 | 71 | 79 | 22 | 15 | 4 | 2 | 0.5 |

County, Colorado) had two setae, lateral and dorsal, on each palpal genu.

Preliminary studies indicate that the scutal measurements of *T. harperi* are larger in the south, smaller in the north. The posterolateral seta (PL) was selected as an indicator of size differences between local populations. The results are summarized in Table 9.

In the Colorado-southern Wyoming region the means of the PL lengths vary from 64 μ in San Juan County, southwestern Colorado to 60 μ in Carbon County, south central Wyoming. In Washakie County (Big Horn Mountains) of north central Wyoming the PL mean was 55 μ. This is significantly smaller than those from Carbon County and is consistent with the fact that the Big Horn Mountains are isolated from the Southern Rocky Mountain region.

In Rio Blanco County, Colorado, little difference was indicated in the PL mean between specimens from 7700 feet (64.1μ) and 10,400 feet (62.5μ), however, the PL measurements from the higher elevation tends to be somewhat smaller than that of the lower elevation, as expected.

*Specimens examined.* Total number 480, as follows: WYOMING—*Washakie County:* 9 mi. E, 4-5 mi. N Ten Sleep, 7000-7400 ft., *Clethrionomys gapperi,* KU 4213-15, 4217-37, 4239-58, 4319—*Microtus longicaudus,* KU 4216—*Peromyscus maniculatus,* KU 4191-4205, 4318—*Tamiasciurus hudsonicus,* KU 4206-12, 4238—*Zapus hudsonius,* KU 4146, 4259, all collected July 14-18, 1947. *Carbon County:* Bridger's Pass, 18 mi. SW Rawlins, 7500 ft., *Clethrionomys gapperi,* KU 4021, 4316-17—*Microtus longicaudus,* KU 4121-24, 4260-4314—*Microtus montanus,* KU 4119-20, 4162-74—*Phenacomys intermedius,* KU 4115-17, 4175—*Zapus princeps,* KU 4118, 4138, 4147-61, 4190, 4315, July 23-25, 1947. COLORADO—*Rio Blanco County:* 5 mi. S Pagoda Peak, 9100 ft., *Microtus* sp., KU 4352-53; 1 mi. NW Pagoda Peak, 10,900 ft., *Ochotona princeps,* KU 4354-97; 9½ mi. SW Pagoda Peak, 7700 ft., *Peromyscus maniculatus,* KU 4340-51—*Zapus princeps,* KU 4320-39, all collected July 27-29, 1947. *Boulder County:* 12½ mi. S Estes Park, 8400 ft., *Clethrionomys gapperi,* KU 4510-44—*Citellus lateralis,* KU 4134, 4493-4504—*Microtus longicaudus,* KU 4423-89—*Neotoma cinerea,* KU 4505-09—*Peromuscus maniculatus,* KU 4491-92—*Zapus princeps,* KU 4490, all collected Aug. 6-8, 1947; 3 mi. S Ward, 9000-9400 ft., *Citellus lateralis,* KU 4398-4405, 4422—*Phenacomys intermedius,* KU 4406-21, all collected July 31-Aug. 1, 1947; 3 mi. N Nederland, *Citellus lateralis,* KU 4546—*Junco hyemalis,* KU 4545, all collected Aug. 15, 1947.

*Douglas County:* 7 mi. N, 4 mi. W Castle Rock, *Neotoma mexicana fallax,* Aug. 4, 1948, KU 4111, 4554-4556. *Gunnison County:* 3 mi. S, 6½ mi. E Crested Butte, 6400 ft., *Neotoma cinerea,* Aug. 10, 1948, KU 4557-63. *Saguache County:* 32 mi. W, 2 mi. N Saguache, 9800 ft., *Neotoma cinerea,* July 4, 1949, KU 4023-24, 4030-31, 4547-53. *San Juan County:* 6½ mi. SW Silverton, 9900-10,100 ft. *Neotoma cinerea,* KU 4606-19—*Zapus princeps,* KU 4565-4605; July 19, 1949. *La Plata County:* 8 mi. N, 1 mi. W Hesperus, 9500 ft., *Neotoma cinerea,* July 4, 1949, KU 4564. PENNSYLVANIA—*Wayne County: Peromyscus maniculatus,* Aug. 1, 1946, KU 4620. MAINE—*Hancock County:* Mt. Desert Island, *Peromyscus maniculatus,* Aug. 19, 1928, KU 4027.

*Additional records.* Brennan and Wharton (1950:171-172): COLORADO—*Jackson County: Microtus pennsylvanicus modestus,* July 14, 1926, 1. *Conejos County: Neotoma* sp., Aug. 19, 1931, 5.

### *Trombicula* (*Neotrombicula*) *browni* Brennan and Wharton

Figures 9 and 10. Tables 3-4, 8-9.

*Trombicula* (*Neotrombicula*) *browni* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 178-179, type: USNM, no. 1840, Washakie Co., Wyo., 9 mi. E, 4 mi. N Ten Sleep, at 7000 ft., *Peromyscus maniculatus,* July 13, 1947. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 57.

*Diagnosis.* A member of the "microti" group with the larval characters as follows: seta on palpal femur and on genu nude; galeal setae usually single branched; first posthumeral row with ten to fourteen setae, more than 40 dorsal body setae; sensilla with few minute barbs.

*Geographic range.* Known only from the type locality in the Big Horn Mountains of northern Wyoming.

*Seasonal occurrence.* The only collections of this species were made in mid-July.

*Remarks.* At least one galeal seta was branched on each of the specimens examined. However, Brennan and Wharton (1950:178) reported that "no barbs could be detected" in one of the four specimens examined. Usually the galeal seta had a single branch, however, two or three branches sometimes occurred. On two specimens one of the galeal setae was nude.

The number of setae in the first posthumeral row varied from ten to fourteen. These were distributed as follows (included are the four specimens reported by Brennan and Wharton 1950:179): ten

setae present on two specimens, eleven on three, twelve on three, thirteen on two, and fourteen on one.

*Specimens examined.* Total number 10, as follows: WYOMING. *Washakie County:* 9 mi. E, 4 mi. S Ten Sleep, 7000 ft., *Microtus longicaudus,* KU 4101-04—*Peromyscus maniculatus,* KU 4105—*Tamiasciurus hudsonicus,* KU 4110—*Zapus hudsonius,* KU 4106-09, all collected July 13-17, 1947.

## Comparison of *T. microti, T. harperi,* and *T. browni*

A comparison of *T. microti, T. harperi,* and *T. browni* specimens from Colorado, Wyoming, and northeastern Utah in the Snow Entomological Museum of the University of Kansas is presented in table 3. These specimens are listed in table 4.

The ten specimens of *T. browni* examined were readily separable from the other two species by the greatly reduced barbs on the sensilla and the larger number of dorsal and ventral setae.

*T. microti* and *T. harperi* apparently are separate sympatric species. The morphological differences are summarized in table 3. The seasonal occurrence of these two species on hosts in the Rocky Mountain region apparently differ; *harperi* has been collected in the late spring and summer (June 11 to August 20) while *microti* has been collected in the summer and early fall (July 19 to October 25). The numbers of larvae of *harperi* and *microti* collected from each county in Wyoming, northeastern Utah and Colorado differ as shown in table 4. It is interesting to note that no *microti* were collected in Washakie County, Wyoming and Boulder County, Colorado, while no *harperi* were collected from Summit County, Utah. The author, therefore, agrees with Brennan and Wharton (1950) in considering these as separate species since they seem to have different but broadly overlapping seasons of activity, and since nearly all of the 578 specimens studied are recognizably distinct.

Nonetheless, there are a few specimens which cannot be satisfactorily placed as to species. By using the presence or absence of branches on the galeal setae and the number of setae in the first posthumeral row, seven of the specimens examined which could not definitely be allocated either to *T. microti* or *T. harperi* are indicated as questionable in table 4; most of the seven specimens were from large series readily identifiable as *microti, harperi,* or a mixture. The county, state and slide number of these specimens are as follows: Carbon County, Wyoming, KU 4148; Rio Blanco County, Colorado, KU 4008, 4009, 4012; Boulder County, Colorado, KU 4134,

4415 (both are listed under *T. harperi*); Dolores County, Colorado, KU 4014. (This specimen, furthermore, has but a few barbs on the sensilla.)

TABLE 3

Comparison of *T. harperi, T. microti* and *T. browni* from the Rocky Mountain Region

| | *T. harperi* | *T. microti* | *T. browni* |
|---|---|---|---|
| Galeal setae | Nude (occasionally one with single branch) | Branched (usually two or more branches) | Branched (usually with single branch) |
| Setae of first posthumeral row | 8 or 9 (seldom 7, 10 or 11) | 6 (occasionally 7)[1] | 10 to 14 |
| Sensillary barbs | Pronounced along entire length. | Pronounced along apical two-thirds. | Few and minute on basal half. |
| Parasubterminala | Usually branched. | Branched or unbranched. | Nude. |
| Body setae: dorsal | 26 to 38 (mean 29) (28 specimens) | 27 to 34 (mean 30) (11 specimens) | 47 to 62 (mean 54) (7 specimens) |
| ventral | 26 to 42 (mean 34) (28 specimens) | 34 to 48 (mean 41) (11 specimens) | 51 to 68 (mean 60) (6 specimens) |
| Total | 54 to 78 | 67 to 79 | 107 to 125 |
| Collected | June to August. | July to October. | July. |

1. The type series of *T. parkeri* Radford, reputedly a synonym of *microti*, has from 6 to 11 setae in the first posthumeral row (Brennan and Wharton, 1950).

## *Trombicula* (*Neotrombicula*) *loomisi* sp. nov.*

Figures 7 and 8. Table 8.

*Diagnosis.* A member of the "microti" group with the following larval characters: all setae of the first four palpal segments feathered; galeal seta branched; several pronounced apical branches on the sensilla.

*Body.* Slightly engorged specimen, length 140 μ, width 99 μ. Eyes two on each side, subequal. Color in life deep red.

*Gnathosoma.* Palpal coxa with feathered seta; femur with dorsal feathered seta; one genu with dorsal feathered seta, the other genu with two feathered setae, one dorsal, the other lateral (five paratypes with a single dorsal feathered seta on each genu, one speci-

* The species is named for Mr. Richard B. Loomis who collected the type material.

TABLE 4

*Neotrombicula* examined from Wyoming, northeastern Utah, and Colorado

| Locality and date | Total | Question[4] | microti | harperi | browni | subsignata | finleyi | autumnalis |
|---|---|---|---|---|---|---|---|---|
| Washakie County, Wyo. July 13–18, 1947 | 79 | | | 69 | 10 | | | |
| Carbon County, Wyo. July 23–25, 1947 | 117 | 1 | 12 | 103 | | 1 | | |
| Summit County, Utah August 2, 1951 | 69 | | 69 | | | | | |
| Rio Blanco County, Colo. July 27–29, 1947 | 87 | 3 | 6 | 78 | | | | |
| Boulder County, Colo. July 31–August 8, 1947 | 156 | 2 | | 148 | | 6 | | |
| Douglas County, Colo. August 4, 1948 | 6 | | | 6 | | | | |
| Gunnison County, Colo. August 10, 1948 | 12 | | 5 | 7 | | | | |
| Dolores County, Colo. October 18, 1949 | 5 | 1 | | | | | 2 | 2 |
| San Juan County, Colo. July 19, 1949 | 56 | | 1 | 55 | | | | |
| Saguache County, Colo. July 31, 1948 | 11 | | | 11 | | | | |
| La Plata County, Colo. July 4, 1949 | 1 | | | 1 | | | | |

4. Questionable specimens are probably either *T. microti* or *T. harperi*.

men, KU 5805, with two setae on one genu as holotype); tibia with dorsal, lateral, and ventral setae, all feathered; tarsus with spur, subterminala, one robust dorsal feathered and six ventral feathered setae. One galeal seta with two branches, the other with three branches (paratypes with one to four branches).

*Legs.* Leg I: coxa, trochanter, basifemur each with one feathered seta; telofemur with five feathered setae; genu with two genualae, microgenuala, and four feathered setae; tibia with two tibialae, microtibiala and nine feathered setae; tarsus with spur, microspur, parasubterminala, subterminala, pretarsala, and approximately 21 feathered setae. Leg II: coxa and trochanter each with one feathered seta; basifemur with two feathered setae; telofemur with four feathered setae; genu with genuala and three feathered setae; tibia with two tibialae and six feathered setae; tarsus with microspur, spur, pretarsala, and approximately 15 feathered setae. Leg III: coxa with seta missing on holotype but base present (paratypes with one feathered seta); trochanter with feathered seta; basifemur with two feathered setae; telofemur with mastifemorala and two feathered setae; genu with genuala and three feathered setae; tibia with tibiala, mastitibiala, and five feathered setae; tarsus with two mastitarsalae and approximately 12 feathered setae.

*Scutum.* Broadly rounded posteriorly (posterior angle of four paratypes tends to be flattened); large and few punctae. Sensillary bases posterior to bases of the posterolateral setae. One sensilla with four apical branches, the other with three (paratypes with three to five apical branches); few minute basal barbs present. Scutal measurements as follows in microns: AW, 69; PW, 94; SB, 28; ASB, 33; PSB, 21; AP, 29; AM, 46; AL, 46; PL, 59; S, 94 (see table 8 for means and the extremes of types).

*Setae.* Dorsal setal formula, 2-6-6-4-6-4; ventral setae 2-2-32 (one paratype, KU 5806, with three humeral setae); total body setae 64. Dorsal body setal measurements as follows in microns: humeral seta, 55; median seta of first posthumeral row, 54; posterior seta, 45.

*Type material.* Holotype (slide no. KU 5803) and two paratypes (KU 5801-02) from *Reithrodontomys megalotis* (field no. RL521102-3), one paratype (KU 5804) from *Peromyscus maniculatus* (RL521102-4), and two paratypes (KU 5805-06) from *Mus musculus* (RL521102-6), all from Yuma County, Colorado, 1 mile east of Laird, at the edge of the North Fork of the Republican River, collected November 2, 1952; one paratype (KU 5807) from *Peromyscus maniculatus* (RL521101-8), from Dundy County, Nebraska,

5 miles north, 2 miles west of Parks, Rock Creek State Fish Hatchery, collected November 1, 1952; all hosts collected by Richard B. Loomis and J. Knox Jones, Jr. The holotype, and four paratypes have been deposited in the University of Kansas Snow Entomological Museum. One paratype each will be sent to the United States National Museum and The Rocky Mountain Laboratory.

*Remarks.* In the key of Brennan and Wharton (1950) *T. loomisi* would key out to *T. jewetti;* however, it differs from the latter in having the apparently unique condition of three to five pronounced apical branches and a few minute basal barbs on the sensilla (figure 7). A comparison of scutal measurements of *jewetti* (Brennan and Wharton, 1950:182) and *loomisi* indicates a difference in the ratio of the PL to the AL; six specimens of *loomisi* had an average of .85μ (.78 to .94), while among five *jewetti* the average was .72μ (.66 to .76).

*Ecology.* The specimen of *T. loomisi* from Dundy County, Nebraska, was taken from a *Peromyscus maniculatus,* at the base of a woodrat nest, in the same general area as the hosts of *T. autumnalis* and *T. whartoni.* However, *loomisi* was in a dry situation while the latter two were found in a marshy habitat. The *loomisi* from Yuma County, Colorado, were taken from hosts trapped in a meadow at the edge of the North Fork of the Republican River which had flowing water present despite the drouth throughout the Great Plains at that time. The soil here was predominantly sandy with a good stand of grass.

The larvae, all unengorged or only slightly engorged, were recovered by washing the mammals in water and detergent. Preliminary examinations revealed only a single unattached larva crawling on the outer hairs of one ear. The rarity (only five larvae from 14 hosts examined from the Colorado locality) and the relatively unengorged condition indicates that these larvae had just appeared (November 1-2) and strongly suggests that this is a late fall and winter chigger.

### *Trombicula* (*Neotrombicula*) *finleyi* sp. nov.*

Figures 11-15, Tables 4 and 8.

*Diagnosis.* A member of the "microti" group with the following larval characters: palpal femur and genu each with branched seta; galeal seta branched; sensilla with pronounced barbs along most of its length; ratio of the PL to the AL .9.

* The species is named for Mr. Robert B. Finley, Jr., who collected the type material.

*Body.* Engorged specimen, length 200 μ, width 145 μ. Eyes two on each side, subequal.

*Gnathosoma.* Palpal coxa with feathered seta; femur and genu each with single dorsal branched seta; tibia with dorsal branched seta, lateral seta of one tibia branched, the other obscure (paratype with both lateral setae nude), and ventral feathered seta; tarsus with setae obscure (paratype with spur, subterminala, single robust dorsal feathered and six ventral feathered setae). One galeal seta with two branches, the other seta obscure (paratype with one seta branched, the other nude).

*Legs.* Leg I: coxa, trochanter, basifemur each with one feathered seta; telofemur with five feathered setae; genu with two genualae, microgenuala, and four feathered setae; tibia with two tibialae, microtibiala, and nine feathered setae; tarsus with spur, microspur, parasubterminala, subterminala, pretarsala, and approximately 19 feathered setae. Leg II: coxa and trochanter each with one feathered seta; basifemur with two feathered setae; telofemur with four feathered setae; genu with genuala and three feathered setae; tibia with two tibialae and six feathered setae; tarsus with microspur, spur, pretarsala, and approximately 15 feathered setae. Leg III: coxa and trochanter each with one feathered seta; basifemur with two feathered setae; telofemur with mastifemorala and two feathered setae; genu with genuala and three feathered setae; tibia with tibiala, mastitibiala, and five feathered setae; tarsus with two mastitarsalae and approximately ten feathered setae.

*Scutum.* Posterior angle rounded; moderately heavy and numerous punctae evenly distributed. Sensillary bases slightly anterior to the bases of the anterolateral setae. Sensilla with pronounced barbs along most of its length. Scutal measurements of holotype as follows in microns: AW, 69; PW, 89; SB, 28; ASB, 30; PSB, 27; AP, 29; AM, 41; AL, 46; PL, 50; S, 90. (See table 8 for measurements of paratype.)

*Setae.* Dorsal setal formula 2-7-7-4-6-3-2, (paratype, 2-6-4-6+12); ventral setae 2-2-35, (paratype, 2-2-38); total body setae 70, (paratype, 72). Dorsal setal measurements as follows in microns: humeral seta 48, median seta of the first posthumeral row 41, posterior seta 44.

*Type material.* Holotype (slide no. KU 4001) and paratype (KU 4002) taken from *Neotoma cinerea orolestes* (field no. RBF 491018-1), Dolores County, Colorado, ten miles east, fifteen miles

north of Dolores, 8250 ft., October 18, 1949, by Robert B. Finley, Jr.; in the Snow Entomological Museum of the University of Kansas.

*Remarks.* *T. finleyi* apparently is closely related to *T. lipovskyi;* however, the former has a branched galeal seta, a different scutal shape, and the means of the PL to the AL in the former is .91 to .92 while that of the latter is .68 to .71. Also *finleyi* has the ASB scutal measurement smaller in relation to the rest of the scutum than in *lipovskyi* (compare fig. 11 with 16 and 23, see table 9). The only locality known for *finleyi* is on the western slope of the Rocky Mountains, while *lipovskyi* has been taken in the Great Plains as far west as northwestern Kansas, approximately 300 miles to the northeast.

In the key of Brennan and Wharton (1950:162), *finleyi* would run to *jewetti* from which it differs in having the sensilla with pronounced barbs along most of its length. The ratio of the PL to AL among five *jewetti* is .66 to .76.

*Ecology.* *T. finleyi* was collected from the same individual host as *T. autumnalis* (see the latter for an account of the locality).

*Trombicula* (*Neotrombicula*) *richmondi* Brennan and Wharton

Table 8.

*Trombicula* (*Neotrombicula*). *richmondi* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, p. 183, type: Somerset Co., Pa., *Microtus pennsylvanicus*, Oct. 16, 1947, Carnegie Museum, Pittsburgh. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 59.

*Diagnosis.* A member of the "microti" group with the larval characters as follows: first four palpal segments with all setae feathered; leg I with a single genuala.

*Geographic range.* This species is known from Arkansas (Polk County) and western Pennsylvania (Brennan and Wharton, 1950: 183).

*Seasonal occurrence.* In Pennsylvania this species has been taken as early as September 27, and as late as April 8 according to Brennan and Wharton (1950:183); in Arkansas the only record was March 29.

*Remarks.* The specimen examined from Arkansas has approximately 60 dorsal and 52 ventral setae while one examined from Pennsylvania has approximately 28 dorsal and 40 ventral setae. There were no other significant differences between the two specimens examined.

*Specimens examined.* Total number 2, as follows: ARKANSAS—*Polk County:* 2 mi. N Wicks, *Peromyscus leucopus,* Mar. 29, 1948,

KU 4005. PENNSYLVANIA—*Westmoreland County:* 2 mi. SSE Rector, *Clethrionomys gapperi,* Feb. 27, 1947, KU 4017.

*Trombicula* (*Neotrombicula*) *lipovskyi* Brennan and Wharton

Figures 1, 16-18, 23. Tables 5, 7-9.

*Trombicula* (*Neotrombicula*) *lipovskyi* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, p. 177, type: USNM no. 1838, Norton Co., Kans., 4 mi. W, 1 mi. S Logan, *Peromyscus maniculatus,* Oct. 25, 1946. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 59.

*Diagnosis.* A member of the "microti" group with the larval characters as follows: all setae on first four palpal segments branched or feathered; galeal seta nude; sensilla with pronounced barbs; scutum broadly rounded posteriorly and with numerous minute punctae.

*Geographic range.* This species is known from Kansas (Norton County) southeastern Nebraska (Richardson County) east to Missouri (Pike and Stoddard counties), southward to Arkansas (Polk County) and Oklahoma (McClain County).

*Seasonal occurrence.* This species has been taken as early as October 7 (Leavenworth County, Kansas), and as late as April 27 (Douglas and Russell counties, Kansas).

*Remarks.* The measurements of the posterolateral setae (PL) (Table 9) and the number of barbs on the sensilla (figs. 16, 23) indicate a northwest-southeast cline. The number of barbs on the sensilla of specimens examined from each area were as follows: nine specimens from Norton County, Kansas, had 15 to 22 barbs (mean 19); nine from Douglas County, Kansas, 8 to 17 barbs (mean 14); ten from Cleveland and McClain counties, Oklahoma, 12 to 20 barbs (mean 16); 10 from Washington County, Arkansas, 9 to 20 barbs (mean 12); 20 from Polk County, Arkansas, 5 to 17 barbs (mean 11).

The body setal counts of 24 specimens from the above five areas were as follows: the dorsal setal count was 30 to 46 (mean 35); the ventral setal count was 34 to 51 (mean 40); and the total body setae were 68 to 86 (mean 76).

Two specimens examined from Norton County, Kansas, (KU 4948, 4967) had both galeal setae with a single branch.

*Habitat. T. lipovskyi* is the most abundant *Neotrombicula* throughout central and eastern Kansas. In northeastern Kansas, particularly Douglas County, where intensive studies have been conducted, this species is known to occur in grassland as well as woodland habitats, as shown by the host data and by chigger

sampling. The six individuals collected on chigger samplers were from the wooded Plot A near the quarry, at the University of Kansas Natural History Reservation (see discussion under *T. sylvilagi*). In other parts of Kansas where collections have been made, the areas were essentially grassland with few or no trees present.

In Arkansas (Washington and Polk counties) *T. lipovskyi* was found on *Sylvilagus floridanus* taken in forest habitats.

*Hosts.* In northeastern Kansas, the most important host of *T. lipovskyi* seems to be *Sylvilagus floridanus* while other important hosts include *Neotoma floridana, Sigmodon hispidus, Microtus ochrogaster,* and *Sciurus niger* in the order of probable importance as hosts. Birds are only minor hosts for this chigger.

The main site of attachment of *lipovskyi* on most of the host species examined appears to be within the ears; however considerable numbers may be found on other parts of the body.

One *Sciurus niger* collected in Douglas County, Kansas had 30 of 50 *lipovskyi* attached just below the ears while none was found within the ears; the other 20 chiggers were from other parts of the body.

Several *Sylvilagus floridanus* collected in Douglas County, Kansas were brought into the laboratory, skinned and divided up into the following divisions: ears, head, feet, the anal and tail region, and the remaining parts of the body. These five portions were washed separately. Two rabbits collected in late November yielded the following combined total of *lipovskyi:* ears, 129; head, 55; feet, 110; anal and tail region, 31; and body, 41. The examination of rabbits during November revealed small pockets of chiggers attached between the toes. It appears that on *Sylvilagus,* the major concentrations of *lipovskyi* are within the ears and on the feet.

Several *Neotoma floridana* nests as well as one unidentified rodent nest (probably *Peromyscus*) were collected in Douglas County, Kansas, in November and December during the height of the *T. lipovskyi* season. They were placed individually into modified Berlese funnels and the residue from the *Neotoma* nests yielded three unengorged and four fully engorged *lipovskyi* larvae, while the unidentified rodent nest yielded one unengorged and three fully engorged *lipovskyi* larvae. Material obtained in the same way from a *Neotoma floridana* nest taken in McClain County, Oklahoma during January, 1952, yielded two fully engorged larvae. This indicates that at least some of the fully engorged *lipovskyi* larvae fall from the

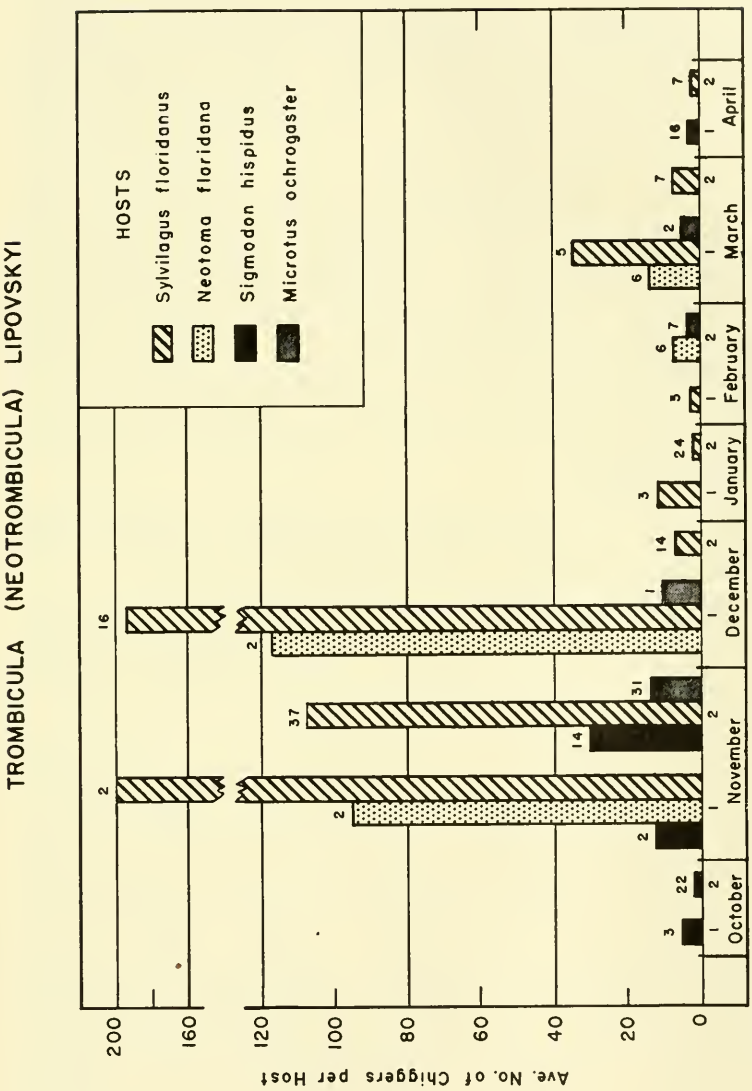


FIG. 1. The total number of larval *T. lipovskyi* recovered per host examined, in each one-half month period from 1947 to 1952 in northeastern Kansas. The number above each bar is the total number of hosts examined during that period.

hosts in the nests and that unengorged larvae are also present in the nests.

*Seasonal abundance.* Northeastern Kansas and central Oklahoma: In northeastern Kansas the earliest larval record of *T. lipovskyi* is from *Sylvilagus floridanus* taken on Oct. 7, 1946, according to Brennan and Wharton, (1950:177). The earliest record during the period studied, from 1947 to 1952, is October 15, 1948, from *Sigmodon hispidus.* The number of larvae upon the hosts during this period (fig. 1) increased rapidly from the few in October to a peak lasting from the second week in November to mid-December, followed by a sharp decline late in December, lasting through January and February, probably due to the cold weather. In late February and early March, there seems to have been a second, but much smaller increase in larval occurrence on hosts, probably due to the warmer weather. Following this was the decline and disappearance of all larvae by the last of April (last record, April 27, 1952, from *Sylvilagus floridanus*).

The seasonal abundance of *T. lipovskyi* on hosts from McClain and Cleveland counties, Oklahoma (Fall, 1951 to Spring, 1952), appeared similar to that found in northeastern Kansas.

Figure 1 presents a summary of the seasonal abundance, from 1947 to 1952, of *T. lipovskyi* in northeastern Kansas from the four most important hosts, *Sylvilagus floridanus, Neotoma floridana, Sigmodon hispidus, and Microtus ochrogaster,* based on one-half month periods.

*Post-larval development.* The required period for the development of *T. lipovskyi* in culture tubes from the engorged larva to the adult was approximately 75 days under laboratory conditions and approximately 300 days outdoors (which included over wintering) as shown in table 5. The culture tubes were 5 dram plastic-stoppered opticlear vials lined with a mixture of hardened plaster-of-Paris and charcoal as described by Lipovsky (1953a). These were kept at the proper humidity by adding water. The nymphs were fed the eggs of *Sinella curviseta* Brook (Entomobryidae, Collembola) as recommended by Lipovsky (1951a). Several of these culture tubes containing approximately 40 fully engorged larvae were kept at room temperature (75°-85° F.) in the laboratory; one culture tube was placed in the refrigerator (39°-42° F.); and one tube was placed outdoors in the soil (November 27, 1951, to July 29, 1952).

The culture tubes in the laboratory were examined every two or

three days, with less frequent examinations of the outdoor and refrigerator tubes.

The outdoor culture tube was placed in a vertical position, two to three inches below the soil surface, which was devoid of vegetation, adjacent to the southwest corner of a building. The soil temperature was recorded as low as 28° F. in December and as high as 92° F. in July.

The duration of the larval stage indicated in table 6 includes the period from the placement of the engorged larvae in the culture tube until they ceased to move their legs. The prenymphal stage (nymphochrysalis or protonymph of some authors), which follows the larval stage, is here divided into two parts: the first being the part of the prenymphal stage which lasts from the time the larval chiggers cease to move until the cuticle starts to split; and secondly, the rest of the prenymphal stage. In order to determine when the larvae have ceased to move and have passed into the first part of the prenymphal stage (not merely inactivity because of the colder temperatures), the outdoor and refrigerator culture tubes were placed in the warm laboratory (temperature 70°-85° F.) for approximately 15 minutes. When first removed from the colder temperatures, usually all of the chiggers were inactive; however, upon warming at the laboratory temperatures, those still in the larval stage became active. When removed from the refrigerator, the larvae were always inactive.

Individuals of *T. lipovskyi* remained as larvae for a considerably longer period at the colder temperatures (62 days outdoors, 72 days in refrigerator) than in the laboratory (6 days).

Those chiggers kept in the refrigerator did not enter the second part of the prenymphal stage until they were removed from the cold temperature (approximately eight to nine months after they entered the first part of the prenymphal stage). However, once transferred to the warmer laboratory, it took only six days for the majority of these chiggers to begin the second part of the prenymphal development; this compares to 19 days for those kept constantly in the laboratory; the difference suggests that some development occurred during the eight to nine months period at 39°-42° F.

The second part of the prenymphal stage did not appear in the outdoor culture tube until the relatively warmer month of March (following the colder months of January and February). The adult stages first appeared during the last half of June, eight months after

the engorged larvae were placed in the culture tube. It appears, therefore, that the larval and the first part of the prenymphal stages overwinter. Furthermore, there seems to be only a single generation of *lipovskyi* per year.

TABLE 5

Post-larval Development of *T. lipovskyi*

| Cultures | | Lab. 70–85°F. | Refrigerator | | Culture tube in soil (outdoors) (Nov. 27 to July 29, 1952) | |
|---|---|---|---|---|---|---|
| | | | 39–42°F. | Lab. | No. days | Months |
| Larva | range[5] | 2–9 | 28–81 | | 10–82 | Nov. 27 to last half of Feb. (overwinter) |
| | median[6] | 6 | 76 | | 62 | |
| | number[7] | (23) | (8) | | (20) | |
| Pre-nymph first part | range | 11–21 | 230–283 | 6–8 | 129–165 | Nov. 29 to first half of April (overwinter) |
| | median | 19 | ..... | 6 | 132 | |
| | number | (21) | ..... | (7) | (19) | |
| Pre-nymph second part | range | 10–22 | ..... | 10 | 32–40 | Last half of March to last half of April. |
| | median | 13 | ..... | ..... | 36 | |
| | number | (20) | ..... | (5) | (14) | |
| Nymph | range | 15–30 | ..... | 44 | 49–81 | Last half of April to first half of July. |
| | median | ..... | ..... | ..... | 51 | |
| | number | (9) | ..... | (1) | (3) | |
| Pre-adult | range | 15–18 | ..... | 17 | 12–18 | Last half of June to last half of July. |
| | median | ..... | ..... | ..... | 13 | |
| | number | (4) | ..... | (1) | (3) | |
| Adult | number pres. | (4) | ..... | (1) | (3) | Appeared the last half of June until last of July. |

5. The range in days that individuals remain in each stage.
6. The number of days before 51 percent of the individuals transform to the next stage.
7. The number of individuals surviving each stage and passing into the next stage.

*Specimens examined.* Total number 950, all in the University of Kansas collection, as follows: NEBRASKA—*Richardson County:* 4-6 mi. W Falls City, *Microtus ochrogaster,* Nov. 30, 1947, KU 4995, 5038, 5109-11, 5203-20. KANSAS—*Norton County:* 3-5 mi. W, 1 mi. S Logan, 85 specimens, all topotypes, *Peromyscus maniculatus,* KU 4948-56, 4965-85—*Reithrodontomys megalotis,* KU 4957-64; —*Sylvilagus floridanus,* KU 4901-47, all collected Oct. 23-30, 1947. *Russell County:* 5 mi. N, 2 mi. E Gorham; *Peromyscus maniculatus,* KU 5694; 7½-9 mi. S Russell, *Peromyscus maniculatus,* KU 5685-93; 5 mi. S Waldo, *Sylvilagus floridanus,* KU 5684; all collected April

26, 1952. *Nemaha County:* 2½ mi. S Sabetha, *Blarina brevicauda,* KU 5094-5105—*Microtus ochrogaster,* KU 5087-93—*Reithrodontomys megalotis,* KU 5106-08, all collected Nov. 30, 1947. *Brown County:* 3 mi. N Hiawatha, *Microtus ochrogaster,* KU 4996-97, 5039, 5074-75, 5080-86—*Peromyscus maniculatus,* KU 5076; 7 mi. N, up to ½ mi. E Hiawatha, *Microtus ochrogaster,* KU 5079—*Rattus norvegicus,* KU 5077; 5 mi. S Hiawatha, *Microtus ochrogaster,* KU 5041-43, 5078—*Mus musculus,* KU 5070-73—*Sigmodon hispidus,* KU 5040; Near Reserve, *Mus musculus,* KU 5112-24, all collected Nov. 29-30, 1947. *Jefferson County:* 5½ mi. N, ½ mi. E Lawrence, *Asio otus,* Nov. 24, 1952, KU 5626-27—*Peromyscus leucopus,* Jan. 29 and Feb. 19, 1952, KU 5667-68, 5670-71—*Richmondena cardinalis,* Jan. 26, 1952, KU 5665—*Sciurus niger,* Nov. 21, 1951, KU 5602-11 —*Sylvilagus floridanus,* Nov. 21-24, 1951, KU 5597-5601, 5622-25, March 15, 1952, KU 5673-77; 6 mi. E Perry, *Neotoma floridana,* KU 5264-65—*Parus atricapillus,* KU 5876-77, both collected Dec. 28, 1948; 7 mi. E, ½-3½ mi. N Valley Falls, *Didelphis marsupialis,* KU 5127—*Sylvilagus floridanus,* KU 5125-26, both collected Nov. 30, 1947. *Douglas County:* 2 mi. W, 1 mi. N Baldwin, *Sylvilagus floridanus,* Nov. 30 and Dec. 4, 1951, 19. Univ. Kans. Nat. Hist. Res., 4-5 mi. N, 1½ mi. E Lawrence, and vicinity, *Centurus carolinus,* Nov. 27, 1948, 1—*Microtus ochrogaster,* Dec. 9, 1948, 1, Nov. 23 and 29, 1951, 5, April 18, 1952, 5—*Neotoma floridana,* Dec. 9, 1948, 13, Nov. 2, 1946, 3, Dec. 6, 1947, 13, Nov. 15, 1952, 11—*Neotoma floridana* nest, Dec. 5, 1948, 2, Dec. 9, 1948, 4—*Peromyscus leucopus,* Feb. 8, 1948, 3—*Peromyscus maniculatus,* Nov. 23, 1951, 1—*Reithrodontomys megalotis,* Nov. 19-29, 1951, 6, Jan. 9, 1952, 1, Feb. 1, 1952, 1—Rodent (probably *Peromyscus*) nest, Nov. 6, 1948, 4—*Sigmodon hispidus,* Nov. 23, 1951, 6—*Sylvilagus floridanus,* Nov. 30, 1948, 10—chigger samplers, Oct. 28, 1951, 1, Nov. 9, 1951, 1, Jan. 14, 1952, 4; 6 mi. W Lawrence, *Sciurus niger,* 12; 2-4 mi. W Lawrence, *Microtus ochrogaster,* March 6, 1949, 1—*Neotoma floridana,* March 30, 1949, 2, Nov. 12, 1949, 17—*Microtus* (*Pitymys*) *pinetorum,* Nov. 29, 1951, 2, Jan. 26, 1952, 1, Feb. 8, 1952, 1—*Neotoma floridana* nest, Nov. 12, 1949, 3—*Sylvilagus floridanus,* March 3-7, 1949, 18, Nov. 12, 1949, 18; Lawrence and vicinity, *Melospiza melodia,* Nov. 25, 1947, 1—*Reithrodontomys megalotis,* Dec. 16, 1948, 3—*Richmondena cardinalis,* Dec. 16 and 28, 1948, 2—*Sigmodon hispidus,* Nov. 3, 1947, 21, Oct. 15, 1948, 17, Nov. 18, 1948, 2—*Sturnella neglecta,* Nov. 5, 1947, 1—*Sylvilagus floridanus,* Nov. 12, 1947, 15, Dec. 16 and 31, 1948, 18, Nov. 28, 1951, 5; 3 mi. S,

1 mi. E Lawrence, Haskell bottoms, *Microtus ochrogaster,* April 8, 1947, 2—*Sigmodon hispidus,* Oct. 25, 1947, 1; 1 mi. W, 3 mi. S Pleasant Grove, *Sylvilagus floridanus,* Dec. 4, 1948, 46, Dec. 29, 1948, 26, Jan. 29, 1949, 8, March 3, 1949, 10, April 21, 1949, 2, Jan. 12, 1952, 4; 4½ mi. S Pleasant Grove, *Sylvilagus floridanus,* April 27, 1952, KU 5683; 3 mi. S Lone Star Lake, *Sylvilagus floridanus,* April 23, 1949, 1; Near Stull, *Canis latrans,* Dec. 14, 1947, 3—*Lepus californicus,* Dec. 14, 1947, 6—*Sylvilagus floridanus,* Dec. 14, 1947, 16, Jan. 2 and 9, 1949, 20, Feb. 7 and 14, 1949, 3; 2 mi. S Worden, *Sciurus carolinensis,* Nov. 26, 1949, 11—*Sciurus niger,* Nov. 26, 1949, 30, Jan. 19, 1950, 3. *Anderson County:* Welda, *Sylvilagus floridanus,* KU 5056-69. *Barber County:* 3½ mi. S, 1 mi. W Aetna, *Neotoma micropus,* KU 5440-48; 5 mi. S Sun City, *Peromyscus* sp. KU 5442-44, both collected April 11 and 12, 1949.

OKLAHOMA—*Cleveland County:* 5 mi. SW Okla. Univ., Norman, *Sylvilagus floridanus,* Feb. 23, 1952, KU 5582; 3 mi. SW Norman, *Sylvilagus floridanus,* Nov. 21, 1951, KU 5548-66; 5 mi. S Norman, *Neotoma floridana,* Dec. 5, 1951, KU 5567-78; 10 mi. SE Norman, *Sigmodon hispidus,* Dec. 28, 1949, KU 5721-42. *McClain County:* 8 mi. SW, 8 mi. W Norman, *Neotoma floridana,* March 14, 1952, KU 5583-85, April 14, 1952, KU 5586-87—*Neotoma floridana* nest, Jan., 1952, KU 5580-81. ARKANSAS—*Washington County:* 2 mi. S Winslow, *Sylvilagus floridanus,* March 29, 1948, KU 5449-84. *Polk County:* 5 mi. W Mena, Rich Mt., *Sylvilagus floridanus,* March 2, 1951, KU 5485-5546, 5702-04.

*Additional records.* Brennan and Wharton (1950:177): KANSAS—*Leavenworth County: Sylvilagus floridanus,* Oct. 7, 1946, 3. OKLAHOMA—*Latimer County: Neotoma floridana,* March 17, 1929, 1. MISSOURI—All from *Sylvilagus floridanus,* Jan. 15-28, 1943, counties and number of specimens as follows: *Caldwell,* 2; *Howard,* 1; *Pike,* 2; *Johnson,* 1; *Pettis,* 1; *Laclede,* 2; *Jasper,* 2; *Stoddard,* 7.

### *Trombicula* (*Neotrombicula*) *whartoni* Ewing

Figures 19-22. Tables 6-9.

*Trombicula whartoni* Ewing, 1929, Ent. News, vol. 40, no. 9, p. 296, Nov., type USNM no. 999, Summerville, S. C., from a bird; 1931, Proc. U. S. Nat. Mus. 80, Art. 8, p. 10. Radford, 1942, Parasitology, vol. 34, p. 57. MacCreary, 1945, Jour. Econ. Ent., vol. 38, p. 127. Michener, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 432. Thor and Willmann, 1947, Das Tierreich, Lief. 71 b, p. 269. Philip and Fuller, 1950, Parasitology, vol. 40, no. 1-2, p. 56.

*Trombicula* (*Neotrombicula*) *whartoni,* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 175-176. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 60.

*Trombicula rohweri* Ewing, 1942, Jour. Parasit., vol. 28, no. 6, p. 488, type: USNM no. 1413, from *Troglodytes aedon,* Harrison Co., Miss., Handsboro, Feb. 14, 1940, coll. G. G. Rohwer, Bish. no. 29458, lot 40-3701. Michener, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 432. Philip and Fuller, 1950, Parasitology, vol. 40, no. 1-2, p. 56.

*Trombicula* (*Neotrombicula*) *rohweri,* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, no. 1, pp. 174-175. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 60.

*Diagnosis.* A member of the "microti" group with the larval characters as follows: all setae on first four palpal segments branched or feathered; galeal seta nude; sensilla with minute to pronounced basal barbs, rarely nude; scutum angular posteriorly and with few large punctae (Arkansas specimens with the punctae somewhat smaller and more numerous).

*Geographic range.* This species is known from southwestern Nebraska (Dundy County), Kansas (Nemaha to Miami counties), Illinois (Champaign County), and Pennsylvania (Dauphin County, south to Florida (Orange County), Mississippi (Harrison to Franklin counties), and northwestward to Arkansas (Miller to Polk counties) and Oklahoma (McCurtain and Adair counties).

*Seasonal occurrence.* In Kansas, Nebraska, and Missouri, this species has been taken as early as October 12 (Miami County, Kansas) and as late as January 28 (Pemiscot County, Missouri). In Arkansas (Polk County), this species has been collected from March 3 to 29.

*Remarks.* Examination of the lectotype and the three cotypes (USNM no. 1413) of *T. rohweri* revealed that all critical characters are consistent with *whartoni.* Brennan and Wharton (1950:175) stated that, "*T. rohweri* is very close to *T. whartoni* from which it is separated by the entirely nude sensillae. However, since both forms occur in the same locality they probably represent two species." However, on careful examination of the four types (USNM no. 1413) with a phase contrast microscope it was found that although most of the barbs were broken off, distinct stumps were present. The number and size of these stumps as well as the few remaining barbs indicate that the barbs are similar to the more pronounced condition found in the Arkansas *whartoni.*

A single specimen from Jasper County, Missouri, listed as *T. rohweri* by Brennan and Wharton (1950:175) was examined and the sensillae were found to be nude. This certainly represents an extreme of *T. whartoni* rather than a separate species, since other specimens within the geographic range of *whartoni* were also found to possess nude sensillae.

The number of barbs on the sensillae of specimens from four areas are as follows: four specimens from Dundy County, Nebraska, with three to five barbs (mean four); 20 from Douglas County, Kansas, with zero to five barbs (mean two); ten from Polk County, Arkansas, with seven to twelve barbs (mean nine); seven from Orange County, North Carolina, with four to seven barbs (mean five) (figs. 19-22).

The specimens from Arkansas and also those from Oklahoma further differ from those examined from Kansas, Nebraska, and North Carolina in having longer barbs on the sensilla, a greater number of punctae on the scutum, and in the shape of the scutum (fig. 22). The characters somewhat approach those of *T. lipovskyi* in Arkansas.

The punctae on the scutum of the North Carolina specimens examined are slightly fewer in number and larger than those from Kansas, Nebraska, and Arkansas.

The posterolateral setal measurements (tables 8 and 9) varied only slightly between the areas studied.

The body setal counts of 16 specimens from the four areas are as follows: the total dorsal setal count was 30 to 43 (mean 35); ventral setal count was 33 to 50 (mean 41); total body (dorsal and ventral) setae 63 to 89 (mean 76).

*Habitat.* In northeastern Kansas, particularly Douglas County, where intensive collecting has been conducted, this species has been found on hosts in deciduous oak-hickory woodland and woodland edge habitats.

The specimens from Polk and Miller counties, Arkansas were taken from hosts in meadow habitats in oak-pine forest areas according to the collectors, Richard B. Loomis and Leonard M. Koger.

The *whartoni* from the Dundy County, Nebraska were taken with *autumnalis* (see habitat notes under the latter). While few trees (small willows), were present, the meadow habitat was marshy.

The specimens from Orange County, North Carolina were taken from Duke Forest.

This species probably cannot withstand the generally drier and colder conditions of the grasslands of the Great Plains and is, therefore, limited to the relatively moist woodlands to the east. When present in the Great Plains it seems to be restricted to woodlands and marshy habitats.

*Hosts.* The most important hosts of *T. whartoni* in northeastern Kansas apparently are *Sciurus niger* and *Sylvilagus floridanus* (see Table 6). Birds are also of some importance as hosts in this area.

Table 6

*Trombicula* (*Neotrombicula*) *whartoni*

collected in northeastern Kansas

| *Host* | *No. examined* [8] | *No. with whartoni* | *Total no. whartoni* |
|---|---|---|---|
| *Sciurus niger* | 12 | 6 | 42 |
| *Sciurus carolinensis* | 1 | 1 | 6 |
| *Sylvilagus floridanus* | 56 | 3 | 69 |
| *Mus musculus* | 30 | 2 | 3 |
| *Parus bicolor* | 2 | 2 | 5 |
| *Richmondena cardinalis* | 9 | 3 | 5 |
| *Junco hyemalis* | 12 | 3 | 4 |
| *Zonotrichia querula* | 6 | 1 | 1 |

*Specimens examined.* Total number 101 as follows: NEBRASKA—*Dundy County:* 5 mi. N, 2 mi. W Parks, Rock Creek State Fish Hatchery, *Microtus ochrogaster,* KU 4893-94—*Microtus pennsylvanicus,* KU 4891-92, both collected Nov. 1, 1952. KANSAS—*Nemaha County:* 2½ mi. S Sabetha, *Mus musculus,* Nov. 30, 1947, KU 4826. *Brown County:* 5 mi. S Hiawatha, *Mus musculus,* KU 4824-25; 1 mi. N Horton, *Richmondena cardinalis,* KU 4817-18, all collected Nov. 29, 1947. *Jefferson County:* 2 mi. NE Perry, *Junco hyemalis,* Oct. 26, 1948, KU 4829-31. *Douglas County:* K. U. Nat. Hist. Res., *Junco hyemalis,* Nov. 9, 1947, KU 4813-16; 7 mi. NW Lawrence, *Sciurus niger,* Nov. 11, 1949, KU 4835-38; 6 mi. W Lawrence, *Sciurus niger,* Nov. 29, 1947, KU 4819-23; 1 mi. W KU campus, Lawrence, *Sylvilagus floridanus,* Dec. 16, 1948, KU 4832-34; 4 mi. S Lawrence, *Parus bicolor,* KU 4808-10—*Richmondena cardinalis,* KU 4812, both collected Nov. 4, 1947; 2 mi. S Worden, *Sciurus niger,* KU 4841-58—*Sciurus carolinensis,* KU 4839-40—*Zonotrichia querula,* KU 4859, all collected Nov. 26-28, 1949; 2 mi. W 1 mi. N Baldwin, *Richmondena cardinalis,* Nov. 4, 1951, KU 4884-85—*Sylvilagus floridanus,* Nov. 30, 1951, KU 4876-83; 3 mi. S Baldwin, *Sciurus niger,* Nov. 28, 1951, KU 4872-75. *Miami County:* 3 mi. E, 1 mi. S Fontana, *Sciurus niger* and *carolinensis,* mixed skins, Oct. 12, 1948, KU 4890. MISSOURI—*Jasper County:* Rabbit, *Sylvilagus* sp., Jan. 24, 1947, Rocky Mt. Lab. no. AP 24274 (listed as *T. rohweri* by Brennan and Wharton, 1950:175). OKLAHOMA—*Adair County:* 1½ mi. E Stilwell, *Sigmodon hispidus,* KU 4896—*Reithrodontomys fulvescens,* KU 4897-8—*Peromyscus mani-*

8. Includes only those hosts examined during the known *whartoni* season (mid-October to mid-December) in this area.

*culatus,* KU 4899-4900, 5879, March 9, 1951. *McCurtain County:* 7 mi. N, 3 mi. E Broken Bow, *Neotoma floridana,* KU 5880, March 27, 1951. ARKANSAS—*Polk County:* 2 mi. NE Mena, along US Highway 71, *Peromyscus maniculatus,* KU 4860—*Reithrodontomys fulvescens,* KU 4862-64—*Mus musculus,* KU 4860-61—*Sigmodon hispidus,* KU 4895, all collected March 3, 1951; 2 mi. N Wicks, *Peromyscus leucopus,* Mar. 29, 1948, KU 4828. *Miller County:* 4 mi. N Texarkana, *Reithrodontomys fulvescens,* Mar. 28, 1948, KU 4827. MISSISSIPPI—*Harrison County:* Handsboro, *Troglodytes aedon,* Feb. 14, 1940, USNM No. 1413 (lectotype and three cotypes of *T. rohweri*). NORTH CAROLINA—*Orange County:* Duke Forest, New Hope Creek Division, Nov. 30, 1947, KU 4801-07.

*Additional records.* Brennan and Wharton (1950:174-177): KANSAS—*Douglas County: Cyanocitta cristata,* 1 specimen, and *Zonotrichia albicollis,* 1, collected Oct. 20, 1946. MISSOURI—All from *Sylvilagus floridanus,* Jan. 15-28, 1943, from these counties: *Linn,* 1; *Carroll,* 1; *Laclede,* 1; *Jasper,* 1; and *Pemiscot,* 1.

## A Comparison of Larval *T. lipovskyi* with *T. whartoni*

TABLE 7

A Comparison of Characters of *T. whartoni* with *T. lipovskyi*

| | *whartoni* | *lipovskyi* |
|---|---|---|
| Scutal shape | angular posteriorly | broadly rounded |
| Scutal punctae | large, few | small, many |
| Sensillary barbs | minute basal barbs few or absent (except Arkansas specimens) | numerous pronounced barbs. |

I am in agreement with Brennan and Wharton (1950) in recognizing *T. whartoni* and *T. lipovskyi* as separate species. They are separable on scutal and sensillary characters as indicated in figures 19-23 and table 7.

In Douglas County, Kansas, these two species are similar in the means of the length of the posterolateral setae as shown in table 10; *T. whartoni* measures approximately 73 μ, while *lipovskyi* measures 74 μ. By contrast, in Polk County, Arkansas, the two species differ considerably in mean PL length.

*Trombicula whartoni* from Polk County, Arkansas, are similar to *T. lipovskyi* in having pronounced barbs on the sensillae; these *whartoni* have seven to eleven while *lipovskyi* have ten to seventeen

barbs. However, these two species from this area differ in the scutal shape and punctae as indicated in figures 22-23. Furthermore, the means of the lengths of the PL setae differ; *whartoni,* 73 μ, *lipovskyi,* 79 μ.

A comparison of the means of the PL (table 9) between the areas studied indicates that the length of the PL of *lipovskyi* varies considerably, while *whartoni* shows little variation.

In northeastern Kansas the seasonal occurrence of *T. whartoni* overlaps the peak of the season of *T. lipovskyi.* Both species seem to appear approximately at the same time, in early October, and reach their greatest abundance in November to mid-December. Larval *lipovskyi* continue to be present on the hosts until April, whereas *whartoni* apparently disappear much earlier. This apparent absence of *whartoni* after mid-December may be due to insufficient host examinations.

*Trombicula lipovskyi* is the most common and widespread *Neotrombicula* in northeastern Kansas, having been taken from a greater number of individuals and species of mammalian hosts and in larger numbers than either *T. whartoni* or *T. sylvilagi.*

While *whartoni* has been taken only from hosts associated with woodland areas, *lipovskyi* has been taken from both woodland and grassland hosts in northeastern Kansas.

A comparison of the numbers of larval *Neotrombicula* collected from birds in northeastern Kansas indicates that *whartoni* is considerably more prevalent on birds than *lipovskyi.* Eighteen of a total of 133 *whartoni* collected in this area were on birds while only ten out of thousands of *lipovskyi* were from birds.

## UNGROUPED SPECIES

Five species with various combinations of the long whiplike setae on the segments of leg III have not been placed into any named groups. Only one of these, *T. sylvilagi,* has been collected from the states included in this paper.

### *Trombicula* (*Neotrombicula*) *sylvilagi* Brennan and Wharton

Figure 2.

*Trombicula* (*Neotrombicula*) *sylvilagi* Brennan and Wharton, 1950, Amer. Midl. Nat., vol. 44, 1950, no. 1, pp. 186-187, type: Rocky Mountain Laboratory no. 23242, Leavenworth Co., Kans., *Sylvilagus floridanus,* Oct. 7, 1946. Wharton and Fuller, 1952, Mem. Ent. Soc. Washington, no. 4, p. 60.

*Diagnosis.* An ungrouped species with the larval characters as follows: two mastitibialae III and two mastitarsalae III; three

genualae I; palpal femur and genu each with one nude seta; galeal seta nude.

*Geographic range.* This species is known from northeastern Kansas (Jefferson, Leavenworth, Douglas, and Miami counties) and central Illinois (Piatt County).

*Seasonal occurrence.* Larvae have been taken on chigger samplers as early as August 16 and as late as December 11 in Douglas County, Kansas. The earliest host record is October 5 (Douglas County, Kansas), while the latest is November 21 (Jefferson County, Kansas).

*Habitat.* Several plots on the University of Kansas Natural History Reservation have been sampled for active unengorged chigger larvae. Two of these plots, one adjacent to the Quarry, called plot A, and another in Skink Woods, along Upper Skink Ledge, called plot B, were found to have *Neotrombicula.* A description of the Natural History Reservation with a map indicating the location of Skink Woods and the Quarry is given by Fitch (1952).

Plot A comprises a total area of approximately 50 square feet. It is situated on a southeast facing slope. Directly adjacent to the west of this area is the open Quarry, which becomes hot, tending, therefore, to raise the temperature of this plot. The principal trees in the vicinity are elms, dogwood, and hickory.

Plot B, approximately 30 square feet in size, is situated on a west facing slope and tends to be cooler and more humid than the Quarry area. Extending over the southern part is an overhanging log (Rat Log) with grass and debris present beneath it. Above the ledge are gooseberry shrubs, walnut, and hackberry trees; below and along the ledge are American elms and *Rhus aromatica.*

Both of these plots are situated on the partially shaded forest floor just below limestone ledges. The well-drained soil of the forest floor covers a limestone derived substrate. The ground cover includes forest litter with a leaf cover present during the fall and winter. The ground in both areas inclines downward from the ledge into the woods. Above the ledge the terrain is level and the trees, which extend but a short distance, are replaced by open grassland. Situated in crevices of the limestone ledges above each of the two areas where *Neotrombicula* were found were *Neotoma* nests.

During the periods of the greatest abundance of *T. sylvilagi,* collections were made in additional areas. These included such habitats as deep within a large cavity at the base of a chestnut oak tree,

on and around a decomposing log deep in the woods, and in grass covered areas adjacent to the woods.

*Seasonal abundance.* The number of active larval chiggers present was determined by placing several black, rectangular "Plexiglass" chigger samplers (5½ x 2½ x ¼ inches)[9] on the areas to be sampled. They were placed firmly on the ground for one or two minutes at the warmer temperatures and five or more minutes during the colder weather. Some samplers were placed on the leaf litter

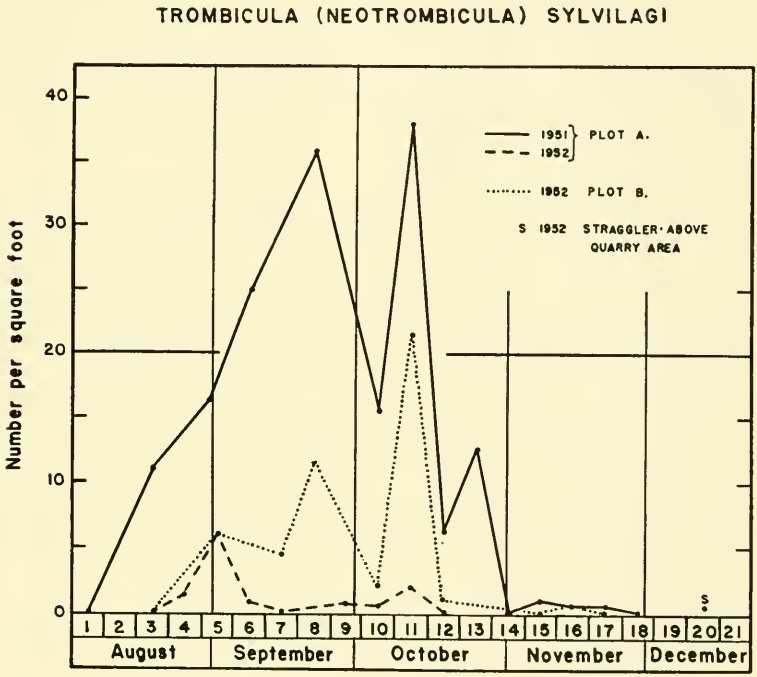


FIG. 2. The estimated number of larval *T. sylvilagi* per square foot, based on larvae taken on chigger samplers, at the University of Kansas Natural History Reservation.

during the height of the larval season for comparison with those placed below; only a slight difference was noted in the abundance of active chiggers. Samples were taken throughout the year; from late spring through fall samples were usually made every one or two weeks, less frequently the rest of the year. The results of the sampling of *T. sylvilagi* are summarized in figure 2. During 1952,

9. This procedure was initiated in 1949 by R. B. Loomis and subsequently followed by him as well as the author (1951 and 1952).

both plots A and B were sampled, while in 1951 only plot A was sampled.

The earliest record of a larval *T. sylvilagi* taken from the soil surface is Aug. 16, 1951. The larval population reached the greatest abundance from early September to mid-October, and rapidly declined until it apparently disappeared by mid-December (latest, December 11, 1952).

The year 1951 was one of the wettest years recorded in eastern Kansas, the rainfall being 15 inches above the normal in Lawrence, and the mammal population during the summer and fall was high, according to Dr. Henry S. Fitch of the University of Kansas Natural History Reservation. Contrary to 1951, the same period (summer and fall) of 1952 was one of the driest on record, with the mammal population dropping extremely low.

During the wet year of 1951, the larval *sylvilagi* were abundant. The few samples made in the plot A station during the months of September and October in 1949 and 1950 indicate that this species was also abundant then; however, the larvae apparently decreased in number more rapidly in these two years than in 1951. The 1952 *sylvilagi* population was considerably below that of 1949 to 1951, probably due to the extremely dry summer and fall. I cannot satisfactorily account for the sharp drop which occurred during the first week of October (week 10 in figure 2).

A single emaciated *sylvilagi* (KU 4794) was collected on December 11, 1952 (see fig. 2) on a sampler placed in a dead grass (*Bromus japonicus*) habitat located immediately above the quarry and adjacent to woodland. This individual appears to have been a straggler and in the larval stage for some time.

The number of chiggers per square foot indicated in figure 2 was obtained as follows: the number of chiggers taken from an area each week was divided by the number of samplers placed on the ground in that area and multiplied by ten (ten chigger samplers cover approximately one square foot). Usually six to eighteen samples were taken. This is not to imply that the entire area has this population, but only the favorable habitats for *sylvilagi*.

*Post-larval development.* Twenty-two unengorged *T. sylvilagi* (field no. RL 521008-10, collected in the field on chigger samplers) were placed on a juvenile *Mus musculus* which was then placed over water containing a synthetic detergent. At the end of three days ten engorged chiggers had been recovered from the water. These ten chiggers were placed together in a Syracuse watch glass

TABLE 8

Scutal Measurements (in microns)

| Locality | No. | AW | PW | SB | ASB | PSB | AP | AM | AL | PL | S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *T. autumnalis* | | | | | | | | | | | |
| Dolores County, Colo. | KU 4003<br>KU 4004 | 72<br>73 | 92<br>97 | 38<br>35 | 31<br>30 | 32<br>33 | 32<br>..... | 48<br>..... | 45<br>..... | 65<br>..... | .....<br>..... |
| Dundy County, Neb. | 10 | 70[10]<br>65—76[11] | 91<br>88—95 | 33<br>31—36 | 30<br>28—33 | 29<br>26—31 | 30<br>28—33 | 48<br>41—51 | 46<br>42—48 | 67<br>61—71 | 76<br>70—81 |
| *T. subsignata* | | | | | | | | | | | |
| Carbon County, Wyo. and Boulder County, Colo. | 6 | 71<br>65—75 | 90<br>77—102 | 29<br>25—31 | 24<br>22—26 | 30<br>28—33 | 26<br>23—28 | 38<br>36—39 | 34<br>31—37 | 43<br>42—44 | 61 (4)<br>58—68 |
| Taney County, Mo. | 1 | 68 | 82 | 28 | 22 | 28 | 23 | 33 | 36 | 40 | 62— |
| *T. microti* | | | | | | | | | | | |
| Summit County, Utah | 5 | 73<br>71—76 | 97<br>95—100 | 30<br>28—31 | 36<br>36—38 | 29<br>28—30 | 33<br>31—34 | 45<br>40—48 | 42<br>39—48 | 60<br>55—67 | 72<br>60—80 |
| Carbon County, Wyo. | 10 | 77<br>75—82 | 98<br>94—105 | 30<br>25—33 | 32<br>31—36 | 29<br>27—31 | 30<br>26—34 | 48 (8)<br>43—51 | 46<br>41—50 | 57<br>51—64 | 80 (6)<br>77—84 |

10. The average of the measurements.
11. Extremes.

TABLE 8—Continued

| Locality | No. | AW | PW | SB | ASB | PSB | AP | AM | AL | PL | S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *T. harperi* | | | | | | | | | | | |
| Washakie County, Wyo..... | 10 | 76<br>71—84 | 93<br>90—95 | 30<br>27—31 | 33<br>31—36 | 27<br>23—28 | 26<br>22—30 | 44<br>41—48 | 44<br>39—50 | 55<br>51—59 | 83<br>70—84 |
| Carbon County, Wyo..... | 10 | 78<br>72—89 | 99<br>89—114 | 32<br>26—41 | 33<br>30—36 | 26<br>24—29 | 29<br>26—32 | 47<br>44—49 | 48<br>41—50 | 59<br>56—64 | 82<br>78—87 |
| San Juan County, Colo..... | 10 | 82<br>73—87 | 102<br>97—107 | 34<br>31—38 | 34<br>31—38 | 27<br>22—29 | 29<br>26—33 | 51<br>45—57 | 50<br>42—58 | 64<br>61—68 | 86<br>80—105 |
| *T. browni* | | | | | | | | | | | |
| Washakie County, Wyo..... | 10 | 80<br>72—84 | 100<br>95—105 | 29<br>28—31 | 38<br>36—40 | 28<br>26—31 | 31<br>28—36 | 49<br>42—55 | 45<br>39—49 | 53<br>43—67 | 89<br>77—98 |
| *T. loomisi* | | | | | | | | | | | |
| Yuma County, Colo. and Dundy County, Neb..... | 7 | 72<br>69—76 | 93<br>89—95 | 28<br>27—30 | 34<br>32—35 | 19<br>17—21 | 29<br>28—31 | 44 (5)<br>40—47 | 47<br>43—52 | 56<br>51—60 | 99 (3)<br>94—103 |
| *T. finleyi* | | | | | | | | | | | |
| Dolores County, Colo..... | Holo.<br>Para. | 69<br>68 | 89<br>91 | 28<br>28 | 30<br>33 | 27<br>23 | 29<br>29 | 41<br>42 | 46<br>41 | 50<br>45 | 90<br>..... |
| *T. richmondi* | | | | | | | | | | | |
| Polk County, Ark..... | 1 | 76 | 87 | 28 | 39 | 23 | 28 | 51 | 49 | 75 | 85— |

TABLE 8—Concluded

*T. lipovskyi*

| Locality | No. | AW | PW | SB | ASB | PSB | AP | AM | AL | PL | S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Norton County, Kan..... | 10 | 67<br>62—77 | 82<br>77—94 | 26<br>22—31 | 36<br>32—39 | 23<br>21—27 | 28<br>26—32 | 47<br>43—51 | 48<br>45—54 | 70<br>67—75 | 84<br>77—91 |
| Douglas County, Kan..... | 10 | 68<br>65—72 | 84<br>80—87 | 26<br>24—28 | 38<br>36—41 | 26<br>23—28 | 30<br>26—33 | 50<br>49—55 | 50<br>48—54 | 73<br>69—78 | 89<br>80—97 |
| Cleveland County, Okla..... | 10 | 66<br>61—68 | 80<br>77—85 | 26<br>23—29 | 36<br>34—39 | 24<br>21—26 | 29<br>26—31 | 49<br>45—54 | 50<br>45—57 | 75<br>71—79 | 90<br>82—99 |
| Washington County, Ark..... | 10 | 72<br>82—65 | 89<br>84—93 | 28<br>26—31 | 39<br>36—42 | 25<br>22—28 | 32<br>28—35 | 55<br>53—60 | 57<br>51—63 | 82<br>80—89 | 95<br>83—104 |
| Polk County, Ark..... | 10 | 69<br>63—72 | 85<br>80—91 | 26<br>24—28 | 39<br>37—42 | 25<br>22—27 | 31<br>28—33 | 51<br>48—56 | 55<br>49—66 | 77<br>71—84 | 94<br>80—121 |
| *T. whartoni* | | | | | | | | | | | |
| Dundy County, Neb..... | 4 | 72<br>71—72 | 86<br>83—88 | 28<br>26—28 | 39<br>38—41 | 27<br>25—28 | 29<br>26—32 | 48<br>46—50 | 52<br>50—58 | 74<br>70—77 | 85<br>76—100 |
| Douglas County, Kan..... | 10 | 67<br>60—74 | 83<br>78—89 | 26<br>24—28 | 38<br>36—41 | 25<br>23—28 | 28<br>26—30 | 46<br>40—51 | 52<br>43—59 | 75<br>68—80 | 87<br>80—100 |
| Polk County, Ark..... | 10 | 65<br>62—69 | 77<br>75—80 | 25<br>23—28 | 37<br>36—38 | 24<br>23—28 | 26<br>23—28 | 45<br>40—50 | 49<br>47—53 | 73<br>71—77 | 89<br>82—93 |
| Orange County, N. C..... | 7 | 68<br>65—72 | 83<br>78—85 | 27<br>25—31 | 37<br>36—38 | 23<br>21—25 | 28<br>26—32 | 47<br>42—50 | 51<br>45—56 | 72<br>70—77 | 90<br>87—96 |

TABLE 9

Comparisons of the Lengths of the Posterolateral Setae of Larval *Neotrombicula* from Different Localities

| County and State | No. | Mean ± S.E.[12] | Observed range [12] | Coeff. of variation ± S.E. |
|---|---|---|---|---|
| *T. lipovskyi* | | | | |
| Norton Co., Kan. | 71 | 69.5 ± 0.42 | 56.5—77.8 | 5.1 ± 0.43 |
| Douglas Co., Kan. | 150 | 73.7 ± 0.31 | 66.4—83.4 | 5.1 ± 0.29 |
| McClain-Cleveland Cos., Okla. | 38 | 73.7 ± 0.45 | 69.2—80.6 | 3.7 ± 0.42 |
| Washington Co., Ark. | 35 | 83.4 ± 0.73 | 74.9—94.8 | 5.2 ± 0.62 |
| Polk Co., Ark. | 59 | 79.1 ± 0.48 | 70.7—87.7 | 4.6 ± 0.42 |
| *T. whartoni* | | | | |
| Douglas Co., Kan. | 45 | 74.8 ± 0.56 | 67.8—80.6 | 5.0 ± 0.53 |
| Polk Co., Ark. | 16 | 73.1 ± 0.59 | 69.2—76.3 | 3.2 ± 0.57 |
| *T. harperi* | | | | |
| Washakie Co., Wyo. | 68 | 55.1 ± 0.38 | 45.1—65.0 | 5.7 ± 0.43 |
| Carbon Co., Wyo. | 84 | 60.1 ± 0.32 | 53.6—66.4 | 4.9 ± 0.38 |
| Rio Blanco Co., Colo. | 68 | 63.6 ± 0.40 | 55.0—70.7 | 5.2 ± 0.45 |
| Boulder Co., Colo. | 130 | 62.3 ± 0.25 | 53.6—72.1 | 4.8 ± 0.30 |
| Gunnison Co., Colo. | 6 | 61.7 ± 1.06 | 57.9—65.0 | 4.2 ± 1.21 |
| Saguache Co., Colo. | 4 | 62.8 ± 1.88 | 59.3—67.8 | 6.0 ± 2.12 |
| San Juan Co., Colo. | 51 | 64.3 ± 0.44 | 59.3—72.1 | 4.9 ± 0.49 |
| *T. microti* | | | | |
| Carbon Co., Wyo. | 9 | 56.9 ± 1.23 | 51.1—63.9 | 6.4 ± 1.51 |
| Summit Co., Utah | 40 | 60.3 ± 0.53 | 55.0—67.8 | 5.6 ± 0.63 |
| *T. browni* | | | | |
| Washakie Co., Wyo. | 10 | 52.7 ± 2.05 | 43.3—66.7 | 12.3 ± 2.71 |

12. All measurements in microns.

with water and detergent and kept in the refrigerator for approximately 2 days; following this they were placed in a culture tube at room temperature. In approximately eleven days (range seven to thirteeen) the six surviving larvae entered the prenymphal stage which was completed in approximately 15 days (range 14 to 17 days) by four individuals. Three of the nymphs were preserved while the fourth remained active for 18 days before becoming inactive and apparently entering the preadult stage; this compares with 21 to 43 days for *T. lipovskyi*. This last individual was preserved after three days of inactivity.

*Specimens examined.* Total number 239, as follows: KANSAS—*Jefferson County:* ½ mi. E, 5½ mi. N Lawrence, *Colinus virginianus,* Nov. 21, 1951, KU 4655. *Douglas County:* Univ. Kans. Nat. Hist. Res., *Cryptotis parva,* KU 4631-32—*Microtus ochrogaster,* KU 4638-49 (19)—*Mus musculus,* KU 4651-54—*Peromyscus manicu-*

*latus*, KU 4628-30, 4635, 4650—*Zapus hudsonius*, KU 4633-34, 4636-37—*Microtus ochrogaster*, KU 4745-47 (6)—*Peromyscus leucopus*, KU 4748-50, Oct. 16-20, 1951-1952—*Richmondena cardinalis*, KU 4623 and *Junco hyemalis*, KU 4621, collected Nov. 9, 1947 —*Chigger samples*, Sept. 24, 1949 (5 specimens), Oct. 10, 1950 (3), Aug. 16-Nov. 21, 1951 (76), Aug. 27-Dec. 11, 1952 (97); near Nat. Hist. Res., *Neotoma floridana*, Nov. 15, 1952, KU 4795-97; North Lawrence, *Turdus migratorius*, Oct. 5, 1947, KU 4622. *Miami County:* 3 mi. E, 1 mi. S Fontana, *Sciurus niger* and *carolinensis*, mixed skins, Oct. 12, 1948, KU 4624-26, 4741-44 (10).

## CLASSIFIED LIST OF HOSTS OF NEOTROMBICULA FROM THE CENTRAL UNITED STATES [13, 14]

### AVES

Galliformes
- *Colinus virginianus* (bob-white quail) *T. sylvilagi*

Charadriiformes
- *Capella gallinago* (Wilson's snipe) *T. subsignata*

Strigiformes
- *Asio otus* (long-eared owl) *T. lipovskyi*

Piciformes
- *Centurus carolinus* (red-bellied woodpecker) *T. lipovskyi*

Passeriformes
- *Cyanocitta cristata* (blue jay) *T. whartoni**†
- *Parus atricapillus* (black-capped chickadee) *T. lipovskyi*
- *Parus bicolor* (tufted titmouse) *T. whartoni*
- *Turdus migratorius* (robin) *T. sylvilagi*
- *Sturnella neglecta* (western meadowlark) *T. lipovskyi*
- *Richmondena cardinalis* (cardinal) *T. lipovskyi, T. sylvilagi, T. whartoni*
- *Junco hyemalis* (slate-colored junco) *T. harperi*†, *T. sylvilagi, T. whartoni*
- *Zonotrichia albicollis* (white-throated sparrow) *T. whartoni**†
- *Zonotrichia querula* (Harris' sparrow) *T. whartoni*
- *Melospiza melodia* (song sparrow) *T. lipovskyi*

### MAMMALIA

Marsupialia
- *Didelphis marsupialis* (Virginia opossum) *T. lipovskyi*

Insectivora
- *Blarina brevicauda* (short-tailed shrew) *T. lipovskyi*
- *Cryptotis parva* (least shrew) *T. sylvilagi*

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13. Includes the following states: Utah, Wyoming, Colorado, Nebraska, Kansas, Oklahoma, Missouri, and Arkansas.

14. Items marked by an asterisk (*) are from Brennan and Wharton (1950). Those marked with a (†) are listed in Wharton and Fuller (1952). The chiggers are listed after the common names of the hosts.

Lagomorpha

*Ochotona princeps* (pika) *T. harperi*†, *T. microti*†

*Lepus californicus* (black-tailed jackrabbit) *T. lipovskyi*

*Sylvilagus floridanus* (eastern cottontail) *T. lipovskyi*†, *T. whartoni*†, *T. sylvilagi**†

Rodentia

*Citellus lateralis* (golden-mantled squirrel) *T. harperi*†, *T. subsignata*†

*Tamiasciurus hudsonicus* (red squirrel) *T. browni*†, *T. harperi*†

*Sciurus carolinensis* (eastern gray squirrel) *T. lipovskyi, T. whartoni*†

*Sciurus niger* (eastern fox squirrel) *T. whartoni, T. lipovskyi*†

*Sciurus carolinensis* and S. *niger*[15] *T. sylvilagi*

*Reithrodontomys fulvescens* (fulvous harvest mouse) *T. whartoni*

*Reithrodontomys megalotis* (western harvest mouse) *T. autumnalis, T. lipovskyi, T. loomisi*

*Peromyscus leucopus* (white-footed mouse) *T. lipovskyi, T. sylvilagi, T. whartoni, T. richmondi*

*Peromyscus maniculatus* (deer mouse) *T. browni*†, *T. harperi*†, *T. lipovskyi, T. loomisi, T. sylvilagi, T. whartoni*

*Sigmodon hispidus* (hispid cotton rat) *T. lipovskyi, T. whartoni*

*Neotoma cinerea* (bushy-tailed wood rat) *T. autumnalis, T. finleyi, T. harperi*†, *T. microti*†

*Neotoma floridana* (eastern wood rat) *T. lipovskyi*†, *T. sylvilagi, T. whartoni*

*Neotoma mexicana* (Mexican wood rat) *T. harperi*

*Neotoma micropus* (southern plains wood rat) *T. lipovskyi*

*Phenacomys intermedius* (mountain phenacomys) *T. harperi, T. microti*

*Clethrionomys gapperi* (boreal red-backed vole) *T. harperi*†

*Microtus longicaudus* (long-tailed vole) *T. browni, T. harperi*†, *T. microti*

*Microtus montanus* (mountain vole) *T. harperi, T. microti*

*Microtus ochrogaster* (prairie vole) *T. autumnalis, T. lipovskyi T. sylvilagi, T. whartoni*

*Microtus pennsylvanicus* (meadow vole) *T. autumnalis, T. harperi**†, *T. whartoni*†

*Microtus richardsoni* (Richardson's vole) *T. microti**†

*Microtus* (*Pitymys*) *pinetorum* (pine vole) *T. lipovskyi*

*Rattus norvegicus* (Norway rat) *T. lipovskyi*

*Mus musculus* (house mouse) *T. lipovskyi, T. loomisi, T. sylvilagi, T. whartoni*

*Zapus hudsonius* (meadow jumping mouse) *T. browni, T. harperi, T. sylvilagi*

*Zapus princeps* (western jumping mouse) *T. harperi, T. microti, T. subsignata*

Carnivora

*Canis latrans* (coyote) *T. lipovskyi*†

## LITERATURE CITED

BRENNAN, J. M., and G. W. WHARTON.
1950. Studies on North American Chiggers. No. 3. The Subgenus Neotrombicula. Amer. Midl. Nat., vol. 44, no. 1, pp. 153-197, pls. 1-4, figs. 1-8, tables 1-2, maps 1-5.

15. Skins from which this chigger was taken were mixed.

FITCH, H. S.
1952. The University of Kansas Natural History Reservation. Univ. Kansas Publ. Mus. Nat. Hist., Misc. Publ. no. 4, pp. 1-38, pls. 1-4, figs. 1-3.

KNIGHT, I. W. M.
1951. A Report on Mites Infesting Muskrat (Ondatra zibethica oseyoosensis) in British Columbia. Canad. Ent., vol. 83, no. 10, pp. 279-280.

LIPOVSKY, L. J.
1951a. Collembola as Food for Chiggers (Acarina, Trombiculidae). Jour. Parasit., vol. 37, no. 3, pp. 324-326.
1951b. A Washing Method of Ectoparasite Recovery with Particular Reference to Chiggers (Acarina-Trombiculidae). Jour. Kansas Ent. Soc., vol. 24, no. 4, pp. 151-156.
1953a. Improved Technique for Rearing Chigger Mites. Ent. News, vol. 64, no. 1, pp. 4-7.
1953b. Polyvinyl Alcohol with Lacto-phenol, a Mounting and Clearing Medium for Chigger Mites. Ent. News, vol. 64, no. 2, pp. 42-44.

RICHARDS, W. S.
1950a. The Variation of the British Harvest Mite (Trombiculidae, Acarina). Parasitology, vol. 40, nos. 1-2, pp. 105-117, figs. 1-23, tables 1-6.
1950b. The Distribution and Biology of the Harvest Mite in Great Britain (Trombiculidae, Acarina). Parasitology, vol. 40, nos. 1-2, pp. 118-126, figs. 1-3, tables 1-2.

WHARTON, G. W., D. W. JENKINS, J. M. BRENNAN, H. S. FULLER, G. M. KOHLS, and C. B. PHILIPS.
1951. The Terminology and Classification of Trombiculid Mites (Acarina: Trombiculidae). Jour. Parasit., vol. 37, no. 1, pp. 13-31, figs. 1-8.

WHARTON, G. W., and H. S. FULLER.
1952. A Manual of the Chiggers. Mem. Ent. Soc. Washington, no. 4, pp. 1-185, figs. 1-17, tables 1-3.

WOMERSLEY, H.
1952. The Scrub Typhus and Scrub Itch Mites (Trombiculidae, Acarina) of the Asiatic-Pacific Region. Rec. S. Australian Mus., vol. 10, parts 1 and 2, pp. 1-673, pls. 1-118, figs. 1-3.

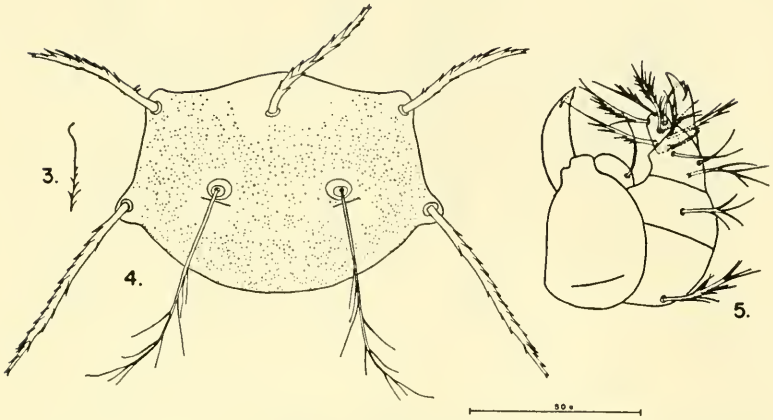
FIGS. 3-6. *Trombicula (Neotrombicula) autumnalis.*

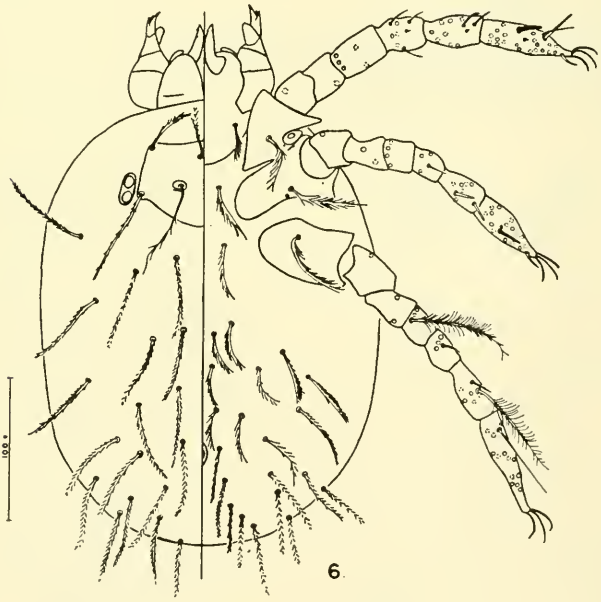
FIG. 3. Apex of the sensilla (KU 4003, Dolores County, Colorado).

FIG. 4. Scutum (KU 4003, from Dolores County, Colorado) and sensilla (KU 5826, Dundy County, Nebraska).

FIG. 5. Gnathosoma (Dolores County, Colorado).

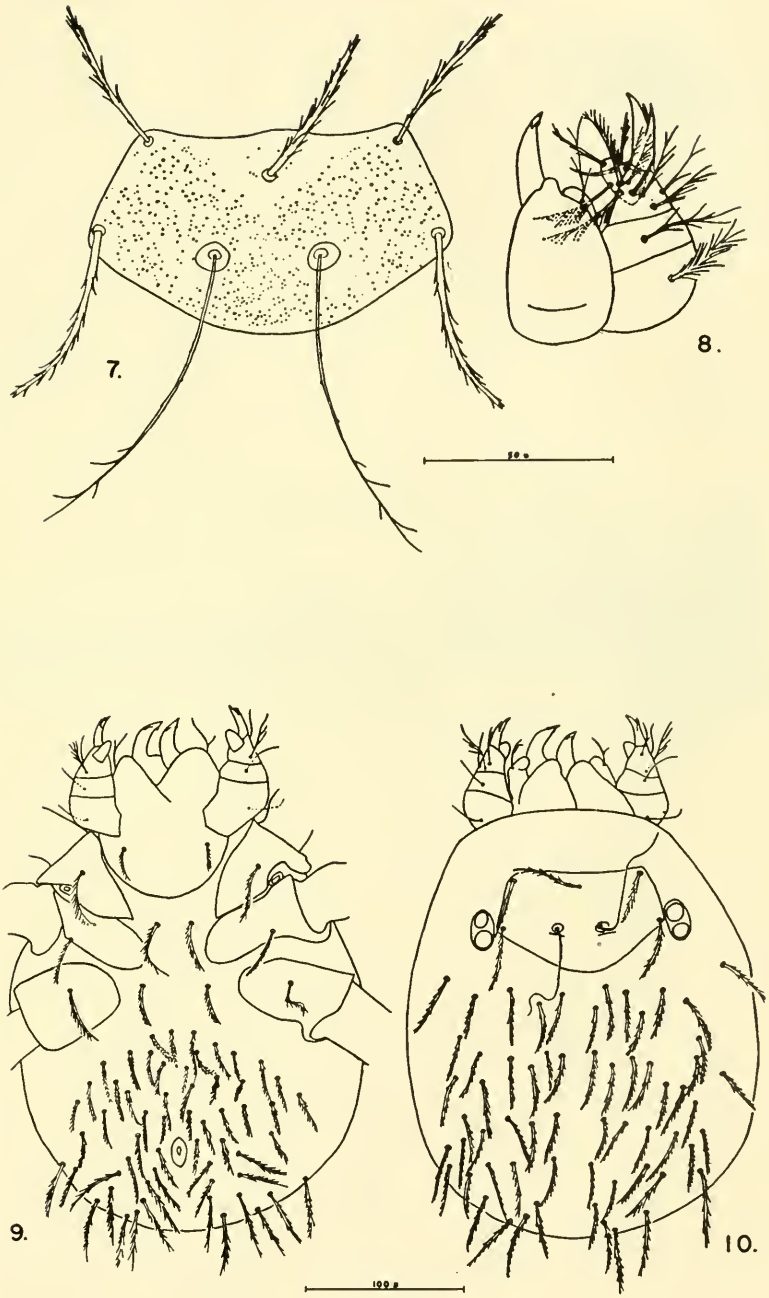
FIG. 6. Body (Dundy County, Nebraska), dorsal view on the left, ventral view on the right; legs (Dolores County, Colorado).




FIGS. 3-6

FIGS. 7-8. *Trombicula* (*Neotrombicula*) *loomisi.*
FIG. 7. Scutum and sensilla.
FIG. 8. Gnathosoma.
FIGS. 9-10. *Trombicula (Neotrombicula) browni.*
FIG. 9. Dorsal view of body.
FIG. 10. Ventral view of body.




FIGS. 7-10

FIGS. 11-15. *Trombicula (Neotrombicula) finleyi.*

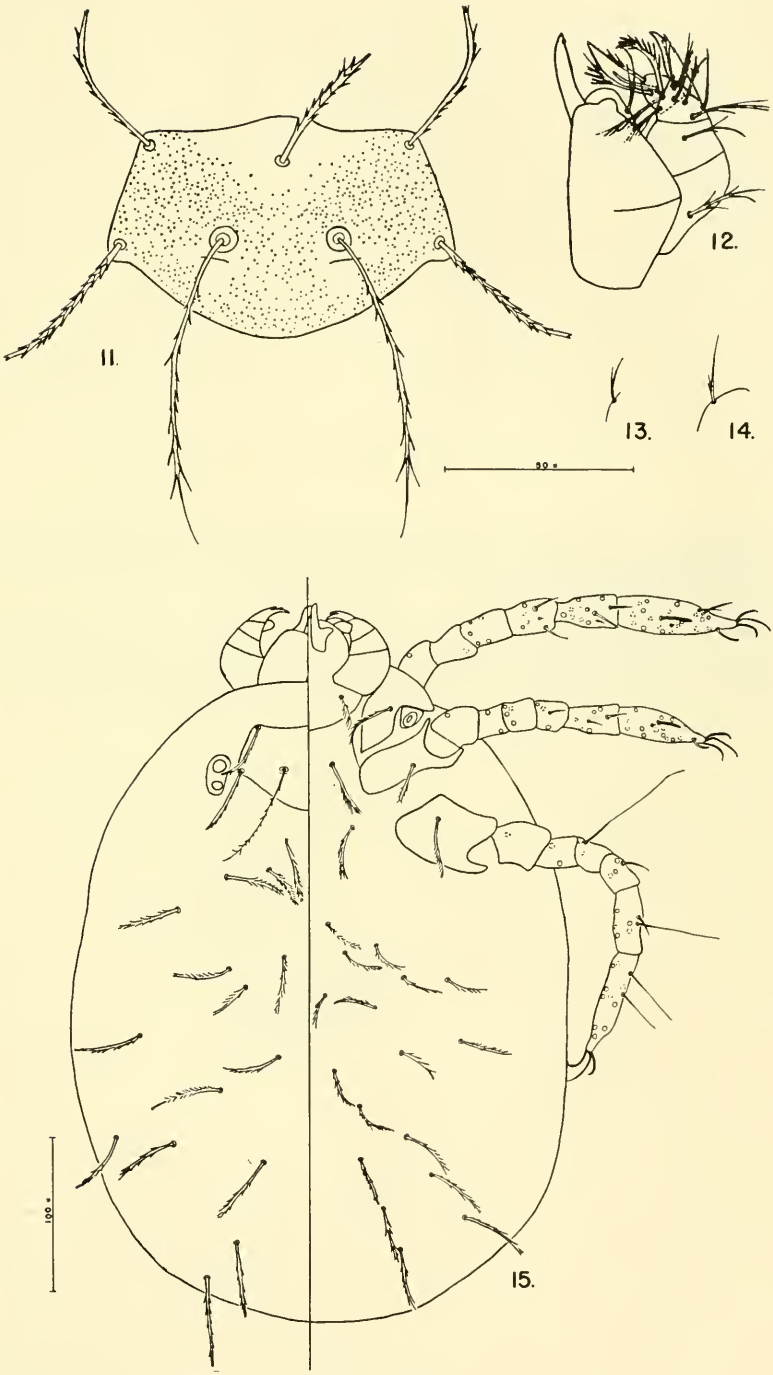
FIG. 11. Scutum of holotype.

FIG. 12. Gnathosoma of paratype.

FIG. 13. Lateral seta of palpal tibia of holotype.

FIG. 14. Galeal seta of holotype.

FIG. 15. Body and legs of holotype, dorsal view of body on the left, ventral view on the right, with the legs showing all nude setae and the bases of branched setae.



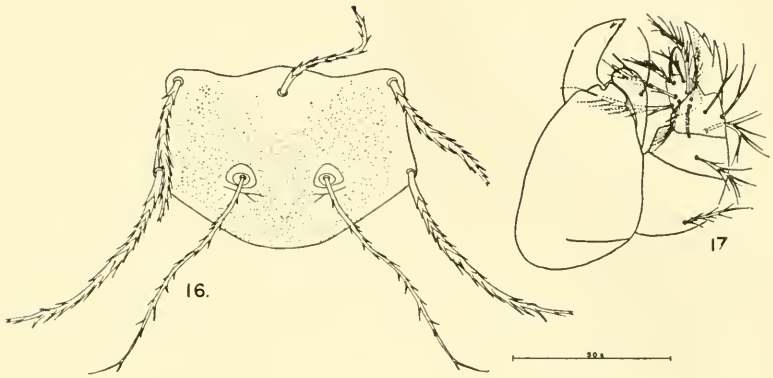

FIGS. 11-15

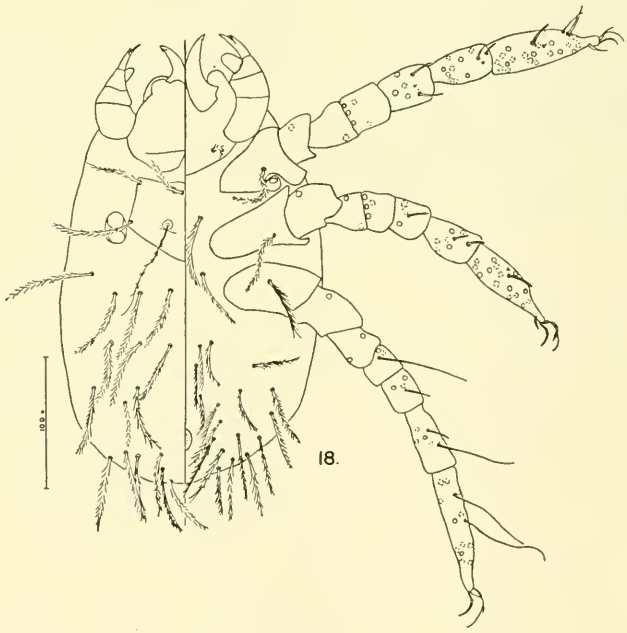
FIGS. 16-18. *Trombicula (Neotrombicula) lipovskyi* (type locality, Norton County, Kansas).

FIG. 16. Scutum and sensilla.

FIG. 17. Gnathosoma.

FIG. 18. Body and legs, dorsal view of body on the left, ventral view on the right, with legs showing all nude setae and bases of branched setae.




FIGS. 16-18

FIGS. 19-22. *Trombicula (Neotrombicula) whartoni.*

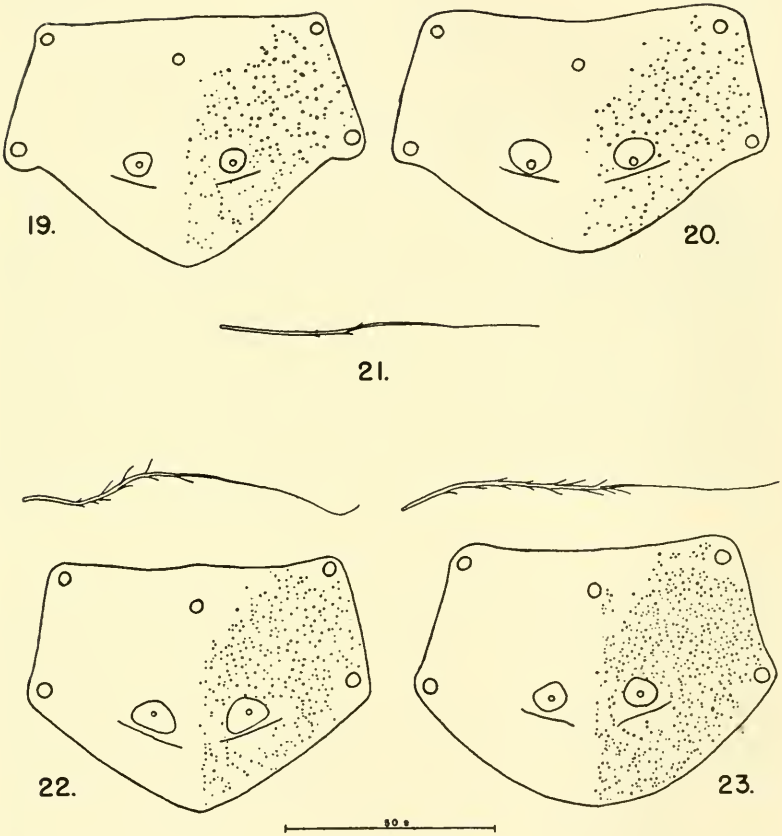
FIG. 19. Scutum (Douglas County, Kansas).

FIG. 20. Scutum (Orange County, North Carolina).

FIG. 21. Typical sensilla in specimens from Dundy County, Nebraska; Douglas County, Kansas; and Orange County, North Carolina, showing the few minute basal barbs present.

FIG. 22. Scutum and sensilla (Polk County, Arkansas).

FIG. 23. *Trombicula (Neotrombicula) lipovskyi.* Scutum and sensilla (Polk County, Arkansas).




FIGS. 19-23

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# Morphological Variations in Mesovelia mulsanti (Hemiptera, Mesoveliidae) [1]

THOMASINE NEERING

ABSTRACT: This paper is a report of studies of variation in a widespread species of small water strider. Characters studied were hair tufts of the eighth abdominal sternum of the male, male genital claspers, and the lobes and prongs of the seventh abdominal sternum of the female. Available specimens were grouped as to area of geographical origin. The variation of each character was divided into a series of classes and the percentage of each class in each area determined. Several classes were found in most such areas and even within local populations. More variants were found in North than in South America; some were found in both continents, some in only one or the other. Except in a few localities no correlation was found between the three characters studied. A most remarkable series of variations is thus revealed. It is concluded that they are of no taxonomic importance.

## INTRODUCTION

The present paper presents a study of the extensive and confusing variation, both geographical and local, in a widespread species of small water strider.

Jaczewski (1930) named four subspecies of *Mesovelia mulsanti* White: *M. mulsanti mulsanti, M. mulsanti caraiba, M. mulsanti meridionalis,* and *M. mulsanti bisignata.* Jaczewski states: "The chief differences between these subspecies are found in the shape of the gonapophyses (forceps, parameres) of the males . . ." However, because there is so much variation of the claspers within each subspecies, and no clear separation of the four subspecies, a great deal of confusion has existed about the group. Herring (1950) states: "These differences (in the male gonapophyses) do not appear . . . to be sufficient to separate this variable species into races." And Usinger (1942) commented: "The trends in

1. Contribution number 833 from the Department of Entomology, University of Kansas.

shape of claspers which prompted Jaczewski to distinguish the subspecies . . . are not evident in my material." Therefore, the purpose of this paper is to clarify some of the confusion in this species by presenting the results of biological, ecological, and distributional studies based on the variations in the hair tufts on the eighth sternum of the males, the claspers, and the extensions from the seventh sternum of the females.

Figure 1. Distribution of Mesovelia mulsanti B White

I would like to express my sincere appreciation to Professor H. B. Hungerford of the University of Kansas for the opportunity to make this study and for the assistance he has given me in completing it. Also, I would like to extend many thanks to Dr. C. D. Michener, chairman of the Department of Entomology of the University of Kansas, for the interest he has shown in this problem and for the great amount of advice and help he has given to me.

I also wish to acknowledge my indebtedness to the Canadian National Collection for the material made available to me and to the University of Michigan Biological Station for the facilities provided for part of this study.

## DISTRIBUTION

The range of *Mesovelia mulsanti* is extensive, including most of the continental Western Hemisphere, from southern Canada in the north to northern Argentina in the south, the island groups in the Carribean Sea, and Hawaii (Williams, 1934; Usinger, 1942). Figure 1 shows only the distribution of the specimens used in this study.

Swamps, bogs, and still pools are the habitats in which *M. mulsanti* is most often found. Winged adults were collected occasionally by the author from streams and from lily pads on an open lake.

The insects are very seldom found on the open water, but rather among the vegetation along the shore, as in bogs, or crawling over any vegetation that may be covering the surface of the water.

## MALES

*Hair tufts.* Jaczewski (1928) mentioned the pair of tufts found on the venter of the eighth abdominal segment of the males, and described differences in the tufts of specimens from Paraná, Brazil and Douglas Lake, Michigan. He decided, however, that he did not have enough specimens from intermediate zones to tell whether or not the tuft differences were significant. Later (1930), he stated: "The black tufts on the eighth abdominal segment of the males do not offer apparently any distinctive characters for the subspecies." He suggested that further study of more specimens was necessary.

In this present study 1,776 male specimens were examined from North, Central, Insular, and South America.

In order to make a numerical study of this character the kinds of hair tufts were separated into six classes as follows:

Group I. Tufts small.

A. Tufts separated, distance between them equal to one and one-half or more tufts. North, Insular, and South America. (Figure 7, o-p.)

B. Tufts set close together, distance between them equal to less than one and one-half tufts. North and Insular America. (Figure 7, q.)

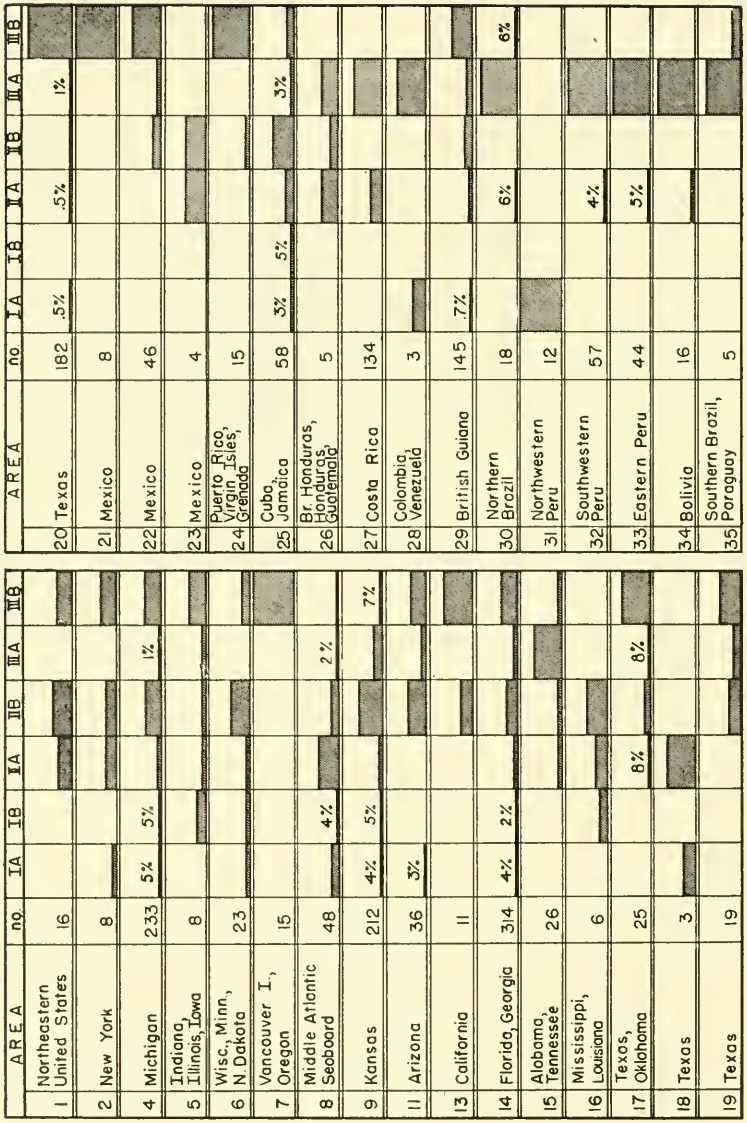


FIG. 2. Histograms showing relative frequency of the six classes of male hair tufts in thirty-five geographical areas. Figures under "no." indicate the number of specimens studied from each area.

Group II. Tufts intermediate in size.

A. Tufts widely separated, distance between them equal to two or more tufts. North, Central, Insular, and South America. (Figure 7, r.)

B. Tufts set close together, distance between them equal to less than two tufts. North, Central, Insular, and South America. (Figure 7, s.)

Group III. Tufts large.

A. Tufts separated, distance between them equal to about one and one-fourth or more tufts. North, Central, Insular, and South America. (Figure 7, t.)

B. Tufts close together, distance between them equal to less than one and one-fourth tufts. North, Central, Insular, and South America. (Figure 7, u-w.)

The percentage of each class in each area outlined in figure 1 is shown in figure 2. The numbers under the column headed "AREA" correspond to the areas on figure 1. Percents less than ten percent are designated.

The specimen from Sonora, Mexico was not included with any numbered area on the map and was omitted from figure 2. This specimen, however, fits into Group II B.

Figure 2 shows that there is a great deal of variation in most of North America, Cuba and Jamaica. Central America and South America show less variation with a predominance of large tufts. In addition to the characteristics of the tufts dealt with in figure 2, the tuft shape varies significantly. In the most easily identified shape variant, the tufts are rounded on three sides and squared along the bottom, and are set close together. This shape is characteristically found in southern Texas (area 20) and northern Mexico (area 21); all of the specimens from the latter area are of this type. Some specimens of this type are also present in areas 7, 13, 14, 17, and 19. The Costa Rican specimens (area 27) fall into two separate groups, but actually they are difficult to differentiate because of intergradation. This same difficulty arose in classifying specimens from Bolivia (area 34) and southern Brasil (area 35). The other localities in South America, with the exception of northwestern Perú (area 31), Venezuela (area 28), and Paraguay (area 35) were identical in that nearly all the specimens have heavy, widely separated tufts. Those from northwestern Perú (31) and the one from Venezuela (28) showed a marked difference from any other hair tuft studied; the tufts contained from 1-5 hairs (Figure 7, o), and on

two specimens tufts were lacking. This character is a possible basis for the recognition of a separate species, which will be discussed later in this paper.

It must be concluded in the case of the hair tufts that there is too much variation for this character to be of use taxonomically. Not only is there a great deal of variation within one area, but also in some cases the variants in widely separated areas are identical (Lakeview, Kansas, and one specimen each from southern Brazil, Costa Rica and Bolivia).

Figure 3 shows the percentage of each class in various local populations from Michigan, Minnesota, Kansas, and Florida and Georgia. Here we see the great variability in hair tufts within populations, which further proves that this character is of no taxonomic value. The specimens from areas 4a to 4g were collected by the author. Each of these areas, with the exception of 4b, is a single bog or pool, so that the specimens studied from each must be members of an interbreeding local population.

It seems unusual that the picture of variation in Lower Matecumba Key, Florida (area 25e) does not resemble Cuba and Jamaica, but instead is more closely allied to Texas (areas 17, 19, 20) and northern Mexico (area 21). The variations in Cuba and Jamaica, however, are also found in the rest of Florida.

*Claspers.* Jaczewski's division of *M. mulsanti* into four subspecies was based on the shape of the claspers.

For this study 125 specimens were used, at least one from each major area in the range. The claspers were separated into four classes, two of which are further subdivided, as follows:

GROUP I. Base of terminal process broad.

- A. Terminal process short. North, Central, Insular, and South America. (Figure 7, a-g.)
- B. Terminal process long, entire clasper larger than I A. North America. (Figure 7, h-i.)

GROUP II. Terminal process slender throughout length.

- A. Terminal process short. Two kinds fall into this class:
  - 1. Terminal process slightly curved. Central America, Insular America, and South America. (Figure 7, j.)

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FIG. 3. Histograms showing relative frequency of the six classes of male hair tufts in certain geographical areas and particular localities. Cheboygan County localities are as follows: Area 4a. Fontinalis Run; Area 4b. Black Lake; Area 4c. Burt Lake; Area 4d. Hook Point pool, Douglas Lake; Area 4e. Bryant's Bog; Area 4f. East Sedge Point pool, Douglas Lake; Area 4g. Sedge Point pool, Douglas Lake. Histograms for areas 4h, 6, 9, and 25 were prepared by excluding from consideration those specimens from these areas utilized in preparing histograms for particular localities.

| | AREA | no | IA | IB | IIA | IIB | IIIA | IIIB |
|---|---|---|---|---|---|---|---|---|
| 4a | Cheboygan Co., Michigan | 11 | | | | | | |
| 4b | Cheboygan Co., Michigan | 39 | 3% | 5% | | | 3% | |
| 4c | Cheboygan Co., Michigan | 21 | | | | | | |
| 4d | Cheboygan Co., Michigan | 42 | 2% | 2% | | | | |
| 4e | Cheboygan Co., Michigan | 33 | 3% | 3% | | | | 6% |
| 4f | Cheboygan Co., Michigan | 13 | | 8% | | 8% | 8% | |
| 4g | Cheboygan Co., Michigan | 4 | | | | | | |
| 4h | Cheboygan Co., Mackinaw Co., Michigan | 64 | 3% | | 6% | | | |
| 4i | Bay Co., Lake Gogebic, Mich. | 6 | | | | | | |
| 6 | Wisc., Minn., N. Dakota | 14 | | | | | | |
| 6a | St. Paul, Minnesota | 9 | | | | | | |
| 9 | Kansas | 39 | 3% | | 8% | | 3% | |
| 9a | Douglas Co. Kansas | 55 | 5% | 4% | 7% | | | 2% |
| 9b | Lakeview, Kansas | 75 | | 3% | 8% | | | |
| 9c | Hutchinson, Kansas | 16 | | | | | | |
| 9d | Cherokee Co., Kansas | 26 | | | | | 4% | |
| 25 | Florida | 155 | 5% | 1% | | | 6% | |
| 25a | Georgia | 24 | | | | | | 4% |
| 25b | Branford, Florida | 43 | | | | 5% | | |
| 25c | Ocala, Florida | 16 | | | | | 6% | |
| 25d | Plant City, Florida | 17 | | | | | 6% | |
| 25e | Lower Matecumba Key, Fla. | 59 | | | | | | |

2. Terminal process incurved giving clasper shape of a U on its side; clasper shorter than (1). Northwestern Perú and Venezuela. (Figure, 7, k.)

B. Terminal process long. Three kinds fall into this class:

1. Base of terminal process greatly curved giving entire clasper the appearance of a question mark. North America: California, Florida, Texas; Central America: Mexico. (Figure 7, m.)
2. Base of terminal process not so curved; base of clasper broad, terminal process curved. North America: Florida. (Figure 7, n.)
3. Base of terminal process slightly curved; terminal process at right angle to clasper base, and only slightly curved. Central and South America. (Figure 7, 1.)

One of the claspers that falls into Group I, A, from Scooba, Mississippi (Figure 7, a), differs radically from all others in this class. The terminal process is short, greatly incurved, rounded and blunt at the tip. This was the only specimen dissected with a clasper of this kind.

Figure 4 shows the presence of the various classes of claspers in each area outlined on figure 1. Since the number of specimens whose claspers were examined is relatively small, percentages of the various areas have not been calculated for they would not be significant. The following comments must be understood to be based on this relatively small number of specimens. They are therefore less reliable than comments based on other characters dealt with in this paper.

Group I, A ranges throughout North, Central, Insular, and South America, although the type of clasper in this class from South America differs from those found in North, Central, and Insular America.

Group I, B is restricted to the United States in the North, East, and Southeast (areas 1, 4, 5, 6, 7, 8, 14, 15), and Kansas (9) and California (13).

One type of clasper that falls into Group II, A has an interrupted range which includes Honduras (area 26) in Central America, Puerto Rico and St. Croix, Virgin Isles (24) in Insular America, and British Guiana (29) and Brazil (30 and 35) in South America.

The other type of clasper in this class is found only in specimens from northwestern Perú (area 31) and Venezuela (28) and differs so greatly from other clasper variations found in *M. mulsanti* that

| AREA | | no. | IA | IB | IIA | IIB |
|---|---|---|---|---|---|---|
| 1 | Northeastern United States | 4 | X | X | | |
| 4 | Michigan | 17 | | X | | |
| 5,6 | Ind., Wisc., Minn. | 4 | X | X | | |
| 7 | Oregon | 1 | X | X | | |
| 8 | Middle Atlantic Seaboard | 4 | X | X | | |
| 9 | Kansas | 6 | X | X | | |
| 11,12, 13 | Arizona, Blythe, Calif. | 4 | X | | | |
| 13 | California | 2 | | X | | X |
| 14 | Florida, Georgia | 22 | X | X | | X |
| 15,16 | Tenn., Ala., Miss., La. | 6 | X | X | | |
| 18,19 | Texas | 6 | X | | | |
| 17,20, 21 | Texas, Northern Mexico | 7 | | | | X |

| AREA | | no. | IA | IB | IIA | IIB |
|---|---|---|---|---|---|---|
| 22 | Mexico | 4 | X | | | |
| 23,26 | Mex., Guat., Br. Hond., Hond. | 4 | X | | X | |
| 24 | Puerto Rico, St. Croix, V. I. | 3 | | | X | |
| 25 | Cuba, Jamaica | 7 | X | | | |
| 27 | Costa Rica | 3 | | | | X |
| 28,31 | Venezuela, N. Peru | 2 | | | X | |
| 28 | Colombia | 1 | X | | | |
| 29 | British Guiana | 6 | | | X | |
| 30 | Northern Brazil | 2 | | | X | |
| 31,33 | Eastern & Southwestern Peru | 4 | | | | X |
| 34 | Bolivia | 4 | X | | | X |
| 35 | Southern Brazil | 2 | X | | X | |

FIG. 4. Table showing the occurrence of the four classes of male claspers in thirty-five geographical areas.

the possibility arises that this may be a new species. A more complete discussion of this will be presented later in this paper.

Group II B represents three different clasper variations, two of which are found in North America, and one in Costa Rica (area 27), Perú (31 and 33), and Bolivia (34). One of the two types from North America is restricted to Florida (14); the other is found in central California (13), Florida (14), southern Texas (20), and northern Mexico (21). This latter type of clasper is associated with the hair tuft which has already been described as characteristic of these areas. There is a considerable amount of clasper variation in North America and Central America. Even in single populations, such as several localities in Michigan and Florida, more than one clasper variant is present. Not as much variation exists in Insular and South America as a whole, or within the separate areas outlined on figure 1; two cases were mentioned above in which the same clasper type was found in Insular and South America.

From this study, therefore, it must be concluded that there is too much variation among the claspers of *Mesovelia mulsanti* for this character to be of taxonomic value.

In general there is no correlation between the type of hair tufts on the eighth sternum of a specimen and its claspers. There are two definite exceptions to this statement however:

1. Specimens from northwestern Perú and Venezuela, all of which have hair tufts containing few hairs, also have the clasper shaped like a U on its side described above (Group II A, 2).
2. All specimens of the large-tufted males from Texas, northern Mexico, and those identical to them from California, and Florida which were dissected have the characteristic question-mark-shaped clasper described above (Group II B, 2).

## FEMALES

When this study of the *Mesovelia mulsanti* complex was undertaken, Dr. Hungerford pointed out several kinds of prongs that extend posteriorly from the seventh sternum of the females, and suggested that they might be of value in this study. Among the 2,166 female specimens examined many different kinds of these extensions were found and were separated into the following classes: (The eighth segment referred to in measurements of the prongs and lobes includes only that portion of the eighth segment extending from the point where the prongs and lobes diverge from it, posteriorly, to its tip.)

Group I. Prongs, all lateral.

A. Prongs slender, long, recumbent to eighth segment, curved ventrally at tip. Michigan, Minnesota, North Carolina, Florida, Georgia, Cuba, British Honduras. (Figure 8, a-c.)

B. Prongs stout, triangular or conical in shape, long or medium in length, protuberant. North America, Cuba, Jamaica, southeastern Mexico, Cost Rica. (Figure 8, d-f.)

C. Prongs stout, very short, protuberant. Indian Hot Springs and Miami, Arizona. (Figure 8, g.)

Group II. Flat lobes, recumbent to eighth segment.

1. Lobes ventral.

A. Long, tips pointed. North America. (Figure 8, h.)

B. Intermediate in length, extending slightly more than one-half the length of the eighth segment, not recumbent at tip. Southeastern Mexico, Colombia. (Figure 8, i.)

X. Short. This theoretically possible type has not been found.

2. Lobes ventrolateral.

C. Long, squared at tip. Cuba. (Figure 8, j.)

D. Intermediate to long, rounded at tip. Four kinds fall into this classification:

1. Lobes three fourths length of eighth segment, tapered at tip. Florida. (Figure 8, n.)
2. Lobes three fourths length of eighth segment, more slender and more lateral than others in this class. Colombia. (Figure 8, k, l.)
3. Lobes one half length of eighth segment, squared at tip. Kansas. (Figure 8, m.)
4. Lobes almost three fourths length of eighth segment, tapered at tip. Northwestern Peru, southern Brazil, Venezuela. (Figure 8, o.)

H. Lobes varying, from very short to almost as long as II, D, some pointed, others rounded. Described in more detail below. North America, Central America, Insular America, South America. (Figure 9, g-l.) (This class was given this classification for purposes of clarity on figure 5; most members of this class are more closely allied to III A than II, D.)

3. Lobes lateral

E. Lobes long, rounded at tip as seen laterally. Distribution restricted to a few areas in United States. (Figure 9, a-b.)

F. Lobes intermediate in length, pointed. North America. (Figure 9, c-d.)

G. Lobes as in II, F, but very short. North America, northern and central Mexico. (Figure 9, e-f.)

GROUP III. Lobes very slightly produced, or absent.

A. Edge of seventh segment slightly lobed or truncate. The following types fall into this classification:

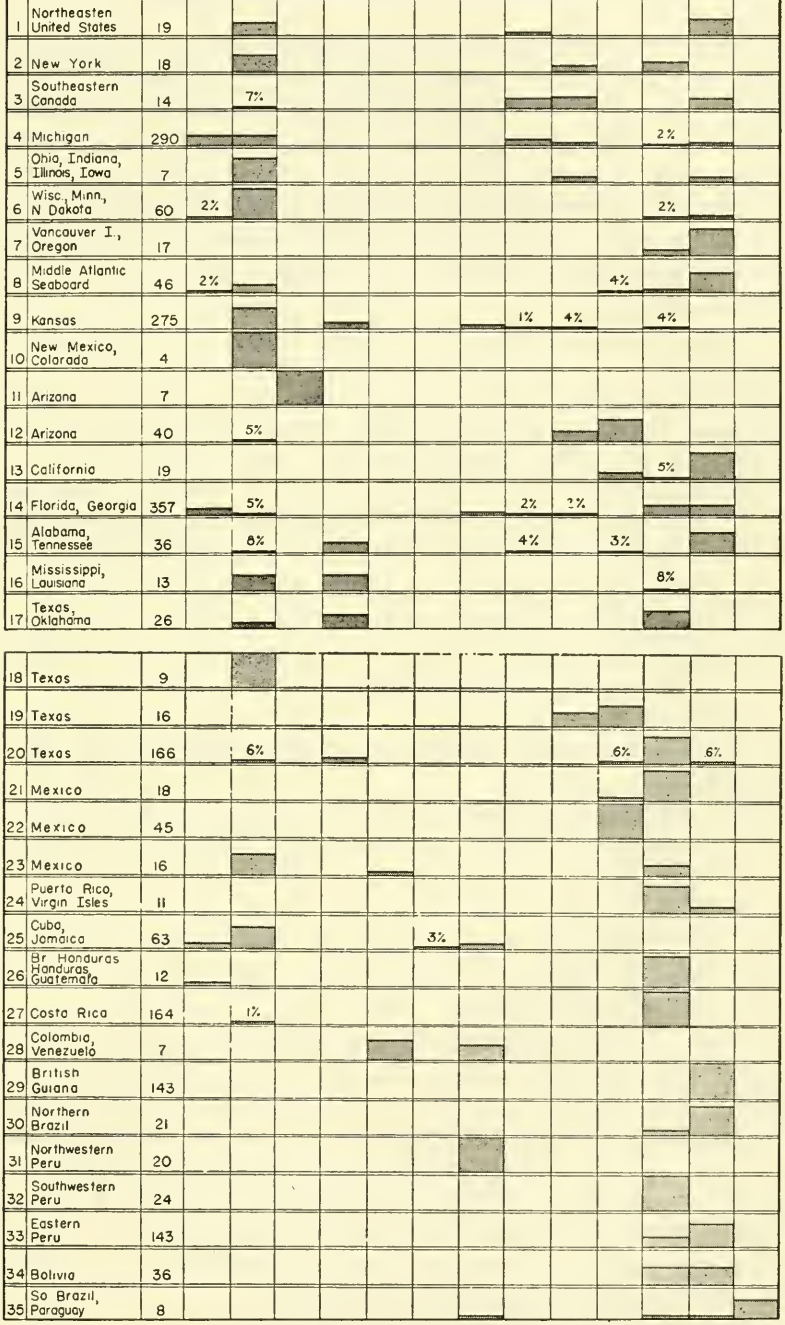
1. Slightly lobed. Oregon, Florida, Puerto Rico, Brazil, British Guiana, eastern Perú, Bolivia. (Figure 9, m.)
2. Truncate. Northern Brasil, British Guiana. (Figure 9. o.)
3. Rounded truncate. North America, Bolivia. (Figure 9, n.)

B. Edge of seventh segment slanting, not lobed or truncate. Paraguay. (Figure 9, p.)

The percentage of each class found in each area on figure 1 is shown in figures 5 and 5a.

Pronged females are found only in North, Central, and Insular America. Group I, A, is unusual in that, although all of these specimens have the same type of prong, the farther south in the range one goes, the less are the prongs bent ventrad at the tip. The specimen from British Honduras is exactly like that from Cuba. Group I, B, represents a wide variety of protuberant prongs, some triangular in shape, others conical and more slender at the tip, and some slightly longer than others. It is striking to note that Group I, C, is found only in two localities in Arizona (area 11), and it is for this reason that these localities represent a separate area in this study.

Group II, A, includes one type of lobed variation that is found in only five areas in the United States (9, 15, 16, 17, 20). Group II, B, is known from Chiapas, Mexico (area 23) and Colombia (28). The type of lobe termed Group II, C, is known only in Cuba (area 25). This type of lobe closely resembles that found on the females of *M. hambletoni* Drake and Harris. The four kinds of lobes which fall into the II, D, classification have already been described. It should be noted here that all specimens from northwestern Perú (area 31), the one specimen from Venezuela (28), and the one from Nova Teutonia in southern Brasil (35) have the same type of lobe (Group II, D, 4). This characteristic, along with the unusual hair tufts and claspers of the males from northern Perú and Venezuela which have already been described, suggest the possibility that these




FIGS. 5a and 5b. Histograms showing the relative frequency of the thirteen classes of variations of the female seventh sternum in thirty-five geographical areas.

specimens may belong to a new species of *Mesovelia.* No male specimens from Nova Teutonia, Brazil were available for study. Because most of the males do have hair tufts, and all specimens have the row of spines along the hind margin of the front and middle femora, this species, if distinct is closely related to *M. mulsanti.*

Groups II, E, F, and G are all closely related; the structure of the lobes is the same, but each class is successively shorter. The shortest (one of the two types in Group II, G) is found only in central Mexico (area 22).

Group II, H, has already been described as representing an assortment of variations, five in all. Some are more closely allied to II, D, others to III, A; the rest are not related to either class. Those that seem to be intermediate in length between II, D (figure 8, m) and III, A (figure 9, m and n) are:

1. Figure 9, k. North, Central, and Insular America: New York, Michigan, Virginia; Veracruz, Mexico; Guatemala; Honduras; Costa Rica; Cuba. (Figure 9, i resembles figure 9, k very closely and has been included in this division.)
2. Figure 9, j. North, Insular, and South America: Georgia, Louisiana, Florida; Cuba, Puerto Rico, Virgin Isles; Perú, northern Brasil, southern Brasil.
3. Figure 9, l. South America: northern Brasil, Bolivia.

The other two types in this class are not closely related to other variations of *M. mulsanti:*

1. Figure 9, h. Range restricted to southern Texas (area 20) and northern Mexico (21), and most specimens from these two areas are of this type.
2. Figure 9, g. Present in Central and Insular America, but predominantly North American: New York, Minnesota, Oregon, Virginia, Georgia, Florida, California, Texas; northern Mexico; Cuba.

In summary, two types in II, H, are found in North, Central, and Insular America, one in North, Insular, and South America, one only in South America, and the other in North and Central America.

Group III, A, also represents more than one type of variation, one of which is found in North, Insular, and South America (figure 9, m), one in North and South America (figure 9, n), and one in South America only (figure 9, o). The type found in North, Insular, and South America seems to be closely related to the one in II, H (figure 9, j) which has the same wide range.

The type of variation represented by Group III, B, is found only

in Paraguay (area 35), and all specimens examined from this locality (Villarrica) are of this type.

It must be concluded, as in the studies of the male hair tufts and claspers, that this great amount of variation among the females is of no taxonomic utility.

Geographically, the variations among the females and the hair tufts on the males follow the same pattern:

1. There is less variation in South America than in North, Central, or Insular America.
2. Large hair tufts on the males and slight lobes on the females both predominate in South America.

## ECOLOGY

As has already been mentioned the habitat of *M. mulsanti* is diverse, including swamps, bogs, open and closed beach pools, and flowing water. Therefore, an ecological study was made in the hope that the results would offer a possible explanation of the variation in the species.

The main part of this study was conducted in Cheboygan County, Michigan, at the University of Michigan Biological Station. Some data were collected in Bay County, Michigan and Douglas County, Kansas.

I. *Bogs.* The following two bogs in Cheboygan County, Michigan were studied:
   1. Bryant's Bog. In wooded area, small, surrounded by tall grasses and *Chamaedaphne.* (Area 4e on figure 6). All females pronged: 90 percent in Group I, A, 10 percent in Group I, B.
   2. Nichol's Bog. Surrounded by meadowland, larger than Bryant's bog, shore along which *M. mulsanti* were collected bordered by short meadow grass, much plant debris floating on the surface. (Not shown on figure 6). All of the females in Group I, B.

II. *Closed Beach Pools.* Two types of closed beach pools were studied: one type was completely covered with *Lemna minor* (duckweed), the other was not.
   A. Beach pools covered with *Lemna.*
      1. Hermitage pond, Burt Lake, Cheboygan County, Michigan.
      2. Carp Creek pond, Cheboygan County, Michigan.
      3. Kaw River pond, Douglas County, Kansas.

None of these ponds is shown on figure 6.

Hermitage pond is a small, lake beach pool, bordered by cattails and with a muddy bottom. The Kaw River pond and Carp Creek pool are both river beach pools, but ecologically similar to Hermitage pond. All females from these three ponds are Group I B.

B. Both closed beach pools used in this study were large, bordered by cattails and with some *Lemna minor* on the surface. Lilies, *Utricularia, Ceratophyllum, Myriophyllum*, and *Spirogyra* were abundant.

1. Fontinalis Run, Cheboygan County, Michigan. (Figure 6, 4a in part). All females from this locality were Group II, F.
2. Bay County, Michigan. (Not shown on figure 6). 83 percent of the females from this pool were Group I, B, 17 percent II, E.

III. *Open beach pools.* Both of the pools in this category are in Cheboygan County, Michigan.

1. Hook Point pool, Douglas Lake. Small, shallow, newly formed, overhung by trees, bordered by sedges; bottom sandy, covered with dead leaves; lilies and *Potamogeton* abundant. (Figure 6, 4d.) 70 percent of the specimens from this pool were Group II, E, 14 percent I, B, 10 percent II, F, and 6 percent III, A.
2. Black Lake pool. Larger, deeper, and older than Hook Point pool, but similar vegetation. (Not on figure 6.) The majority of specimens (66 percent) from this locality were Group I, B; the rest were II, D (5 percent), II, E (10½ percent), II, F (10½ percent), and III, A (8 percent).

IV. *Running water.*

1. Fontinalis Run, Cheboygan County, Michigan. Water slow-moving; lilies, *Potamogeton,* and *Ceratophyllum* present. *Mesovelia mulsanti* were collected from among the lilies. (Figure 6, 4a in part). Five percent of the females were I, B, 50 percent II, E, and 45 percent II, F.
2. Bessey Creek, Cheboygan County, Michigan. Water faster moving than in Fontinalis Run, and deeper. *M. mulsanti* were collected from among the grasses which bordered the stream near its mouth; very few were collected from among the lilies and *Potamogeton* upstream. (Not shown on figure 6.) The majority of the females from this stream (67 percent) were Group III, A; the rest were Group II, F (22 percent) and I, B (11 percent).

TABLE I.—HABITATS OCCUPIED BY FEMALE VARIANTS OF M. MULSANTI

| Habitat | Group | | | | | |
|---|---|---|---|---|---|---|
| | I A | I B | II D | II E | II F | III A |
| Bogs | x | x | ..... | ..... | ..... | ..... |
| Closed beach pools | ..... | x | ..... | x | x | ..... |
| Open beach pools | ..... | x | x | x | x | x |
| Streams | ..... | x | ..... | x | x | x |

Table I shows that certain types of female variants are found in different ecological situations, and that the variation cannot be predicted by knowing the ecology of the habitat.

Detailed studies of the male hair tufts and claspers in relation to ecology were not made, but areas 4d, e, f, and g on figure 3 show that there is great variation in hair tufts within one habitat, and that one type can be found in different ecological habitats.

The claspers, too, vary within a locality. Usinger (1942) states that "the male genital claspers are fairly constant for any given locality . . .," but the author found that several clasper variants may be present in one locality.

It must be concluded, therefore, that the great amount of variation in this species is not dependent upon ecology.

## BIOLOGY

Excellent accounts of the life history and habits of *Mesovelia mulsanti* have been given by Hungerford (1920) and Hoffmann (1932).

This species is thought by most authors to overwinter in the adult stage. Shore debris was collected in November from Lakeview, Kansas and brought into the laboratory, but no specimens were found, adult or nymphal. Twigs were examined for eggs, but none were detected. The stage of hibernation of this species still remains unknown.

Crosses between several types of males and females were attempted in the hope that something of the genetics of this problem in variation would be discovered. However, the virgin females that were reared died before they could be mated and lay eggs. Females that were collected and brought into the laboratory were examined and the variation of each was recorded. Then they were

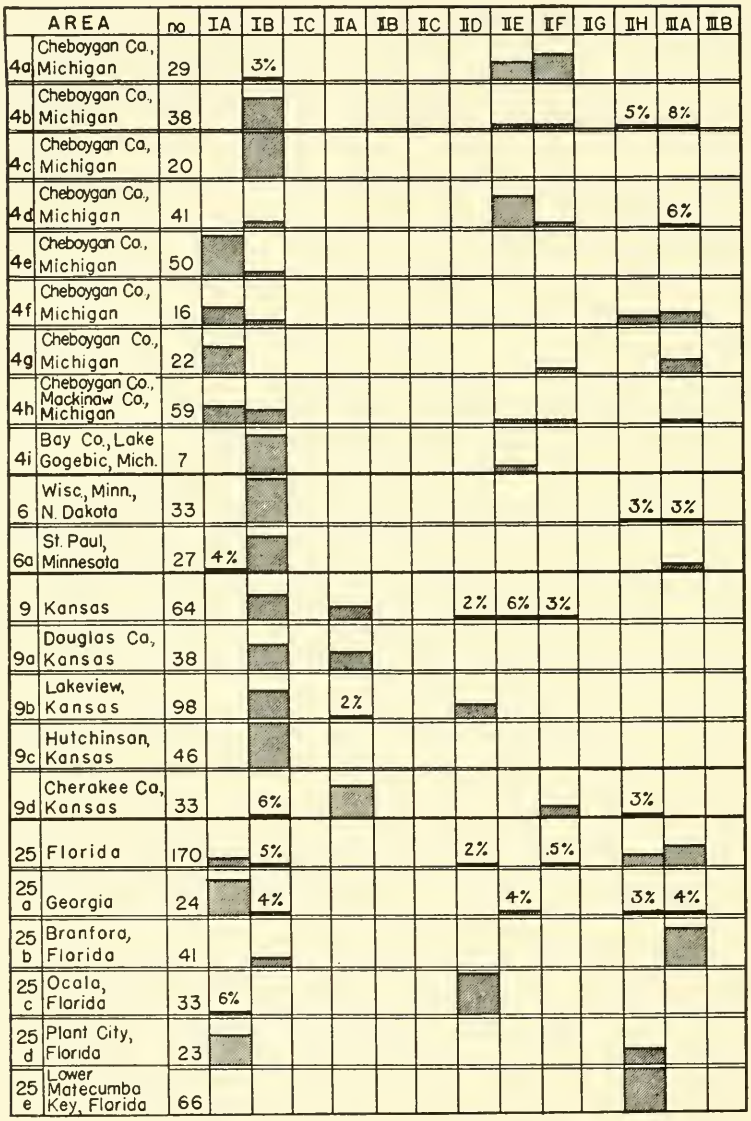



FIG. 6. Histograms showing relative frequency of the thirteen classes of variations of the female seventh sternum in certain geographical areas and particular localities. Cheboygan County localities are as follows: Area 4a. Fontinalis Run; Area 4b. Black Lake; Area 4c. Burt Lake; Area 4d. Hook Point pool, Douglas Lake; Area 4e. Bryant's Bog; Area 4f. East Sedge Point pool, Douglas Lake; Area 4g. Sedge Point pool, Douglas Lake. Histograms for areas 4h, 6, 9, and 25 were prepared by excluding from consideration those specimens from these areas utilized in preparing histograms for particular localities.

placed in separate stender dishes to lay eggs. A great percentage of the eggs hatched, but only sixteen nymphs reached the adult stage. The females that produced these offspring were from two localities: (1) Lakeview, Kansas, and (2) pools along the Kaw River, Lawrence, Kansas. Of the sixteen adults, eight were females, offspring of mothers from Lakeview, and eight were males, six the offspring of mothers from Lakeview, and two the progeny of a mother from the Kaw River. The variations represented by the offspring as compared with the mothers are summarized in Table II. (All of the variations of the males from Lakeview are represented in figure 3, area 9b, of the females, in figure 6, area 9b.)

TABLE II.—COMPARISON BETWEEN OFFSPRING AND FEMALE PARENT VARIATIONS OF M. MULSANTI

| Locality | Female parent | Female progeny | Male progeny |
|---|---|---|---|
| Lakeview, Kan. | 6 ♀♀ of female Group II D | 7 ♀♀ of female Group II D | |
| Lakeview, Kan. | 1 ♀ of female Group I B | 1 ♀ of female Group I B | |
| Lakeview, Kan. | 2 ♀♀ of female Group I B | | 2 ♂♂ of male Group I A |
| Lakeview, Kan. | 1 ♀ of female Group II D | | 1 ♂ of male Group I A |
| Lakeview, Kan. | 1 ♀ of female Group I B | | 1 ♂ of male Group I B |
| Lakeview, Kan. | 1 ♀ of female Group II D | | 2 ♂♂ of male Group II B |
| Kaw River, Kan. | 1 ♀ of female Group I B | | 2 ♂♂ of male Group I B |

Study of this table shows that in these few instances, the female offspring did not differ from the female parent, but that the same type of mother can produce different types of male offspring.

It should be noted, too, that one mother (II, D) produced two female offspring of the same class; another mother (II, D) produced two males of the same type, Group II B; and that a third mother also produced two identical male offspring. In these instances there was no conspicuous variation among the female or male progeny of one mother.

Because these results are based on such sparse data they are of little value except as possibilities that can be followed in later

work on this problem. Many more experiments should be made, with virgin females which can be crossed with any desired type of male.

A new technique was used in crossing and rearing. Matings were made in one-inch stender dishes with 2-3 layers of moistened toweling paper covering the bottom. After mating the male was removed, and the female laid her eggs in the top layer of paper, just as she would in a twig. This method greatly simplified counting the eggs, for the top layer of paper could be removed, turned over, and all eggs were plainly visible. Also, the development of the egg could be observed from day to day. Hatching was normal. Care had to be taken to keep the papers moist in the dishes, and to keep fungus out.

Upon hatching, each nymph was transferred to a separate dish with moist toweling paper. All specimens were fed on fruit flies (*Drosophila melanogaster*) which had been wounded to prevent them from flying about in the dish.

Most of the mortality among the nymphs occurred during the third instar. Perhaps this could have been avoided by transferring the nymphs to dishes of water after the second instar molt, and using this standard method of rearing until the adult stage was reached.

## SUMMARY

A distributional study of *Mesovelia mulsanti* based on the variations in the male hair tufts and claspers, and the prongs and lobes, or their absence, on the females is presented, along with the results of ecological studies of these characters.

The variation in the hair tufts is of no taxonomic utility; there is too much variation within a locality, and the same type of variation is present in widely separated localities.

The clasper variations, although not as numerous as the types of hair tufts, are also too extensive to be of taxonomic value. Jaczewski's subspecies based on this character are, therefore, invalid.

The variations of the female character are more numerous but more distinct than the male hair tufts. They, too, exhibit a confusing lack of pattern that makes them useless taxonomically.

The variation is not correlated with differences in the habitats of this insect.

The solution to this problem may be genetical. Structurally identical mothers bore female offspring that were identical to the mother, but different mothers of the same structural type did pro-

duce structurally different male offspring. In no instance were structurally different males or females reared from any single mother.

A new technique in rearing *M. mulsanti* was developed by allowing the females to lay their eggs in damp toweling paper.

## LITERATURE CITED

HERRING, JON L.

1950. The aquatic and semiaquatic Hemiptera of northern Florida, Part 2: Veliidae and Mesoveliidae. Florida Entomologist, vol. 33, no. 4, pp. 148-149.

HOFFMANN, CLARENCE H.

1932. The biology of three North American species of Mesovelia. Canadian Entomologist, vol. 64, pp. 88-95, 113-120, 126-139.

HUNGERFORD, H. B.

1920. The biology and ecology of aquatic and semiaquatic Hemiptera. Univ. Kansas Sci. Bull., vol. 11, pp. 3-265, plates I-XXX.

JACZEWSKI, TADEUSZ.

1928. *Mesoveliidae* from the State of Paraná. Annales Musei Zoologici Polonici, vol. 7, nos. 2-3, pp. 74-79, plate IV.

1930. Notes on the American species of the genus Mesovelia Muls. Annales Musei Zoologici Polonici, vol. 11, no. 1, pp. 3-11, 2 plates.

USINGER, R. L.

1942. Notes on the variation and distribution of *Mesovelia mulsanti* White. Bull. Brooklyn Ent. Soc., vol. 37, p. 177.

WILLIAMS, F. X.

1934. *Mesovelia mulsanti* White. Proc. Hawaiian Ent. Soc., vol. 8, no. 3, p. 378.

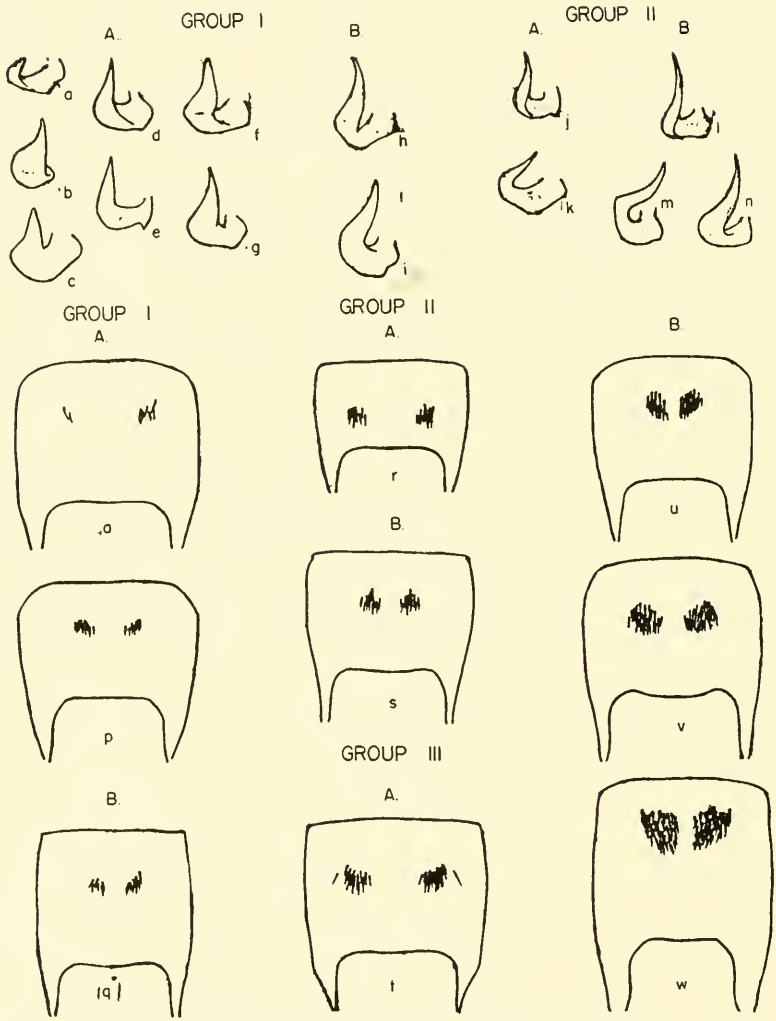



FIG. 7. Clasper and hair tuft variations of *Mesovelia mulsanti*. a. Scooba, Mississippi; b. Rió Beni, Victoria, Bolivia; c. Bay County, Michigan; d. Arivaca, Arizona; e. Hutchinson, Kansas; f. Ocala, Florida; g. Bryant's Bog, Cheboygan County, Michigan; h. Black Lake, Cheboygan County, Michigan; i. Hook Point, Douglas Lake, Cheboygan County, Michigan; j. Caomo Springs, Puerto Rico; k. Vic. Pacasmayo, Perú; l. Vic. Tingo Maria, Perú; m. Brownsville, Texas; n. Eridn, Florida; o. Vic. Pacasmayo, Perú; p. Hutchinson, Kansas; q. Catalina, Havana Prov., Cuba; r. Rió Beni, Victoria, Bolivia; s. Bryant's Bog, Cheboygan County, Michigan; t. San José, Costa Rica; u. Bessey Creek, Cheboygan County, Michigan; v. Arivaca, Arizona; w. Fontinalis Run, Cheboygan County, Michigan.

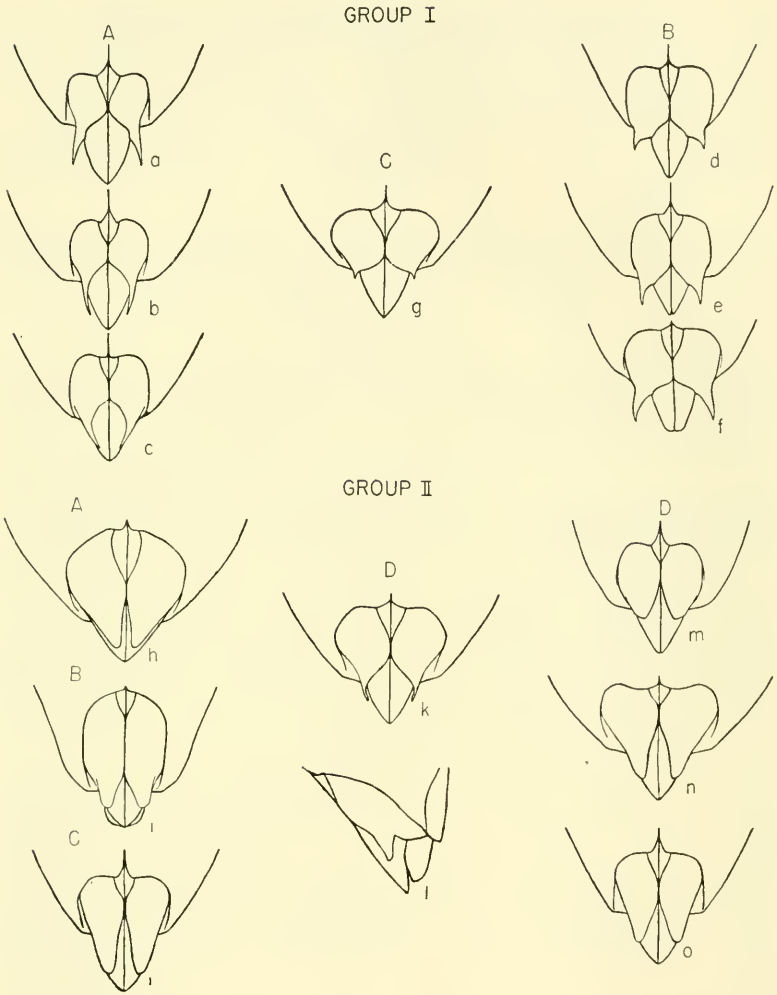



FIG. 8. Variations in the seventh sternum of females of *Mesovelia mulsanti*. a. Palpite Cienaga de Zapate S. C. Prov., Cuba; b. Rió San Juan, Pueblo Nuevo, Mantanzas, Cuba; c. East Sedge Point pool, Douglas Lake, Cheboygan County, Michigan; d. Catalina, Havana Prov., Cuba; e. Hutchinson, Kansas; f. Burt Lake, Cheboygan County, Michigan; g. Miami, Arizona; h. Decatur County, Kansas; i. Dept. Atlantico, Piojo, Colombia; j. Palpite Cienaga de Zapate S. C. Prov., Cuba; k. Dept. Atlantico, Bocas de Geniza, Colombia (ventral view); l. lateral view of (k); m. Lakeview, Douglas County, Kansas; n. Lacoochee, Florida; o. Vic. Pacasmayo, Perú.

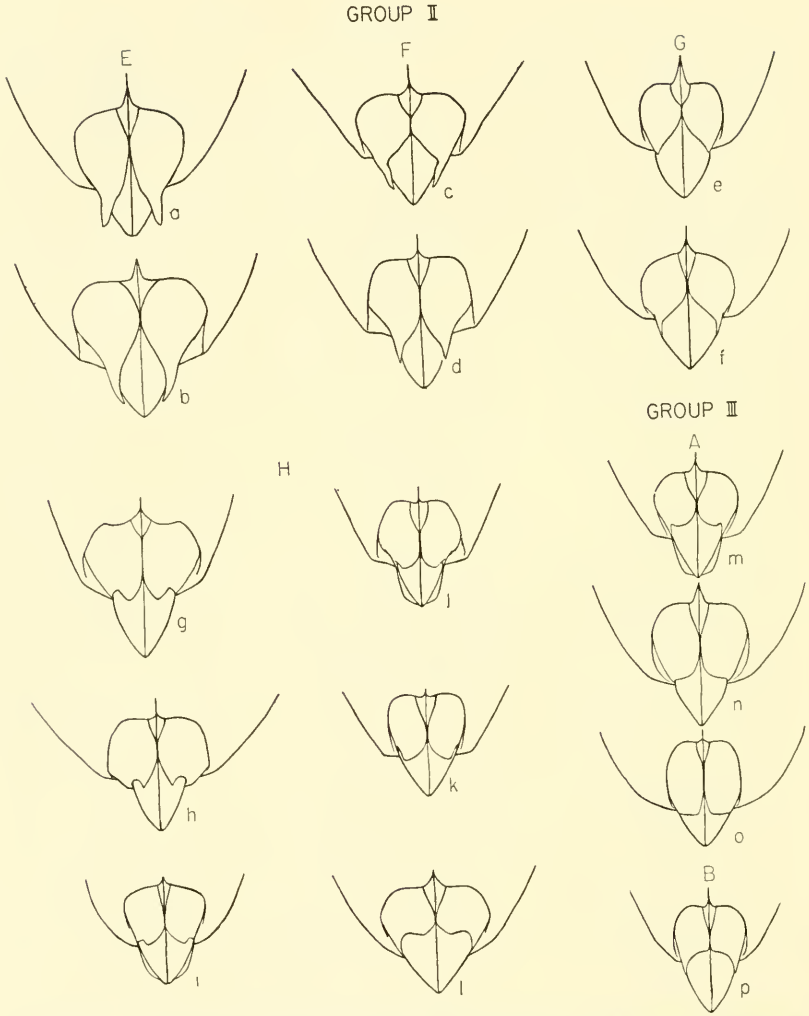



FIG. 9. Variations in seventh sternum of females of *Mesovelia mulsanti*. a. Black Lake, Cheboygan County, Michigan; b. Black Lake, Cheboygan County, Michigan; c. Fairy Lake, Quebec; d. Fontinalis Run, Cheboygan County, Michigan; e. México, D. F., Mexico; f. Arivaca, Arizona; g. Plant City, Florida; h. Brownsville, Texas; i. St. Croix, Virgin Isles, Christiansted; j. Mouth of Rió Rimac, Dept. Lima, Perú; k. San José, Costa Rica; l. Lago Grande, State of Pará, Brasil; m. Vic. Sani Beni, Perú; n. Hook Point, Douglas Lake, Cheboygan County, Michigan; o. Kangarooma, British Guiana; p. Villarica, Paraguay, South America.

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# A Revision of the Bee Genus *Colletes* in America North of Mexico (Hymenoptera, Colletidae) *

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Abstract: This paper consists of a monographic revision of the bee genus *Colletes* in America north of Mexico. It is primarily a taxonomic study although some information is included on the biologies of several species, some speculation on the phylogeny and distribution of the genus, and a brief consideration of the nomenclature of the male genital segments.

Previous to this paper some 167 forms had been described from America. An alteration of previous synonymies and revision of existing forms have resulted in the treatment of 95 species and 16 subspecies which are described in detail.

Twelve new species are described: *Colletes aridus, C. arizonensis, C. beamerorum, C. bulbotibialis, C. ciliatoides, C. kansensis, C. longifacies, C. micheneri, C. mitchelli, C. saritensis, C. swenki,* and *C. timberlakei.* In addition, two new subspecies are named: *Colletes fulgidus longiplumosus* and *C. punctipennis maurus.*

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## INTRODUCTION

The bee genus *Colletes* abounds in America north of the Tropic of Cancer and is widely distributed throughout the world, with the exception of Australia. This study is limited to those species occurring in America north of Mexico, for material from Mexico and the Central American countries is meagre and the areas of collection remote.

The work is primarily of a systematic nature and contributes little to an evolutionary or phylogenetic study of the genus. However, in conjunction with Noskiewicz's (1936) treatise on the Palearctic members of the genus plus a critical treatment of the Latin American fauna, it should form a suitable basis for the inauguration of such a project.

Swenk (1908) published the first extensive systematic paper on the American species of the genus. His work considered twenty-six species possessing some black thoracic pile in either or both sexes. He experienced a great deal of difficulty in obtaining accurately determined material, and recent inquiry indicates that he had opportunity to examine but a few of the types. Despite his effort to avoid the use of chromatic characters for species differentiation, he was occasionally forced to do so; where these lapses occurred the species picture was obscure. In spite of these shortcomings the Swenk work was laudable and unique until the Timberlake papers on Colorado (1943) and California (1951) *Colletes* appeared. In addition to these treatises, several species lists and incomplete keys have been compiled, usually accompanied by descriptions of new species. All, except the Swenk work, are regional in scope and are unsatisfactory to workers outside of the zones covered. The original descriptions are, for the most part, unsatisfactory in the light of present knowledge, frequently referring solely to the color of the body pile and to other characteristics now known to be of infraspecific value only.

As a result, all species are herein redescribed with the exception of a few not available to me and a few known only from single females. These are listed in the text and addenda with their original descriptions. Most, if not all, of the monotypes may eventually prove to be conspecific with better-known species, but further investigation is necessary. An attempt was made to standardize descriptive techniques: holotypes, paratypes, or topotypes, in descending order of availability, were selected for the basic description with variation over the species range recorded in a preamble or postscript

to each description; the first paragraph of the description deals with the distribution, density, and color of the pile of the body, beginning at the clypeus and extending progressively caudad, terminating with an account of the pubescence on the metasomal sterna; the second paragraph includes a discussion of the integumental morphology of the insect in the same sequence. In most of the descriptions of species a brief summary of the characters of the seventh ventral plates and capsule of the male is given, and in each of them there is reference to illustrations at the end of the work.

The locations of the types of the new species are indicated in the text, and insofar as is possible the paratypes may be found in the University of Kansas collection, the Canadian National Collection, the United States National Museum, and my personal collection.

The conventional synonymy precedes the descriptive portion of each species. Included are some records, obviously erroneous, that are well out of the known range of distribution for the species. In some instances I have had an opportunity to examine material (of Swenk, Graenicher, Criddle, etc.) upon which earlier publications were based. In an effort to make the work as comprehensive as possible the reference lists have been included in their entirety. Where any question exists in my mind on the validity of a specific record, a clarifying note, in parentheses, follows that item. References to the Cresson (1887), Dalla Torre (1896), and Michener (*In* Muesebeck *et al.*, 1951) catalogues have not been included for it is felt that their inclusion would entail unnecessary repetition.

The greatest difficulty in the descriptive phase of this work was experienced with the color of the body pile. This problem lies not only in the fact, as Swenk suggests, that "the original color undergoes a rapid fading, so that a specimen in which the hair of the thorax and face was of a bright yellowish color when fresh will, in a short while, fade to pale grey without a tinge of yellow . . ." but also to an equal or greater extent on the inherent polychromatic nature of the pile. In a number of species there is so much color variation that accurate description would necessitate the consideration and subsequent treatment of at least twenty-five per cent of the individuals. *C. thoracicus* is the prime example of this variability. Typically this species has the pile of the body, particularly of the head and the thorax, uniformly ochreus to ferrugineous, but in many specimens the pile is tawny or dusky grey much as in the closely related species *inaequalis* Say. Other individuals of this species have a few hairs of the mesoscutum and scutellum so deeply

dusky-ferrugineous that they may be confused with black. I suspect that some of this variation can be attributed to fading but this is not the only cause of it. Throughout the genus there are many species in which a little black pile is present on the scutellum or vertex or both of a large percentage of the population but is absent in other individuals. Similarly, variation in the intensity of yellow pigmentation of the pile often occurs on specimens taken in a single area during a single flight season.

There is little doubt that the presence of abundant black hairs, whether on the face, vertex, or thoracic dorsum, serves as a character of value. However, I doubt whether it is of much phyletic significance. The presence of black pile in some species in many diverse groups merely indicates that the character has arisen independently and repeatedly during the evolution of the genus.

Hazardous, as a specific character, is the use of slight differences in the density of body pubescence. With age many, if not all, species lose pile, probably because of abrasion during the construction of their nests. The thoracic and metasomal terga are most susceptible to repeated contact and, consequently, the metasomal fasciae are often reduced or absent, depending on the age and sex of the specimen. Despite its limitations, I do not advocate that consideration of the body pile be eliminated in species determination, but caution against its use and when possible would restrict it to the secondary role of characters to be employed principally in substantiation of conclusions based on other morphological characters.

A number of characters regularly used previously in species recognition have also proved unreliable when generally applied. Those dealing with the intensity of color of some morphological structure are of little value, except when applied to species of a restricted range. The degree of melanism varies in the general body color of the insect; in the coloration of the underside of the flagellum; in the extent of red and black on the apices of the mandibles; in the color of the nervures of the wing; and in the shade of the tarsi and tegulae. These have all proved equally unsatisfactory for the more widely distributed species, and reference to such characters has been kept to a minimum.

Difficulty in species recognition is by no means restricted to chromatic variation. In the widely distributed species minor variations are found in the punctation of the clypeus and vertex, the sculpture of the basal area and posterior face of the propodeum, the

patterning and pitting of the metanotum, and the pectination of the spurs of the hind tibiae to the extent of negating or impairing the use of the structures as specific characters. Again, it must be emphasized that the above characters become increasingly useful in species of restricted distribution, where geographical variation becomes a negligible factor.

## NOTES ON MORPHOLOGY OF THE MALE GENITALIA

The variation in terminology of the various structures of the primary copulatory organs of the male is disturbing; the list of terms is resplendent with synonyms and appears to be increasing with each of the more recent papers. Crosskey (1951) has done little to clarify the situation with his introductory statement, "It has been conclusively shown that the male genitalia of Hymenoptera are entirely phallic in origin." Few morphological problems in entomology remain so unsettled. His failure to consider the basic contributions by Crampton (1919, 1920, 1938), Singh-Pruthi (1925, 1929), and Michener (1944) leads one to consider the statement no more than a personal expression of satisfaction with the conclusions of Snodgrass (1941). Despite the uncertainty that enshrouds the homologies of the primary copulatory organs I find the work of Michener and Crampton much more plausible than claims for exclusive phallic origin of the capsular structures. Michener (1944) wrote: "Holometabolous insect larvae do not have 'legs' on the ninth abdominal segment, which is the segment upon which the claspers are situated, or if appendages are present as in the larvae of Trichoptera, they give rise to claspers. It seems certain then, that at least the outer claspers, and the inner ones as well except possibly in Orthoptera, are, like the gonopore, associated with the ninth abdominal segment." The appendages which do eventually appear on the ninth segment in Hymenoptera are presumed to be serially homologous to the "legs." As Michener points out, the copulatory organs are much less likely to be new structures of phallic origin than derivatives of pre-existing structures.

The terminology used in this paper to describe the primary copulatory organs (capsule) is that of Michener with slight modification. Frequent reference is made to the membranous expansions, or wings, of the penis valves for they offer excellent specific and group characters. The ventral wing is broad and readily distinguishable in all species except *C. ciliatus* Patton, in which it is reduced to a semilunar preapical expansion. A number of species, particularly those

of the *consors* group, also have the dorsal margin of the penis valves broadly convoluted and extended laterally in a plane parallel to the ventral wings. These two expansions I have termed the dorsal and ventral wings of the penis valves. This is done despite Timberlake's previous use of the term "lateral wing" for the ventral lamina. As both wings often occur as lateral projections I feel that the use of "lateral wing" would eventually add to the confusion. I have followed Snodgrass' terminology for the apical portions of the volsellae, *i. e., cuspis* for *lateral process, digitus* for *median process* (Figure 87).

Noskiewicz (1936) based his capsular nomenclature on the work of Strohl (1908) and frequently referred to appendicular terms as employed by Schmiedeknecht (1882-1884). An attempt to synonymize the various names used by the principal workers in dealing with the copulatory structures of Hymenoptera is shown in Table I.

I have treated the seventh metasomal sternum as being composed of two separate plates attached to a narrow transverse basal apodeme. Throughout the genus the two plates are united at their mediobasal margins. The seventh ventral plates, despite their simplicity, are undoubtedly the most useful morphological structures for species differentiation, and I have arbitrarily applied names to

TABLE I

Synonymy of terms applied to the primary copulatory organ in Hymenoptera

| Michener (modified) | Snodgrass | Schmiedeknecht | Strohl | Timberlake |
|---|---|---|---|---|
| gonobase | basal ring | cardo | cardo | |
| gonocoxite | parameral plate | stipes | valvae | stipes |
| gonostylus | parameres | lacinia | external | apical segments of stipes |
| penis valves | sagittae | sagittae | sagittae | sagittal rods |
| dorsal wing | | | lamellae | dorsal wing |
| ventral wing | | | | lateral wing |
| volsellae | volsellae | | valvae internal | volsellae |
| cuspis | cuspis | | | |
| digitus | digitus | | | |

portions of the plates for ease in verbal description. The rounded basal points of attachment I have termed the "basal articulatory condyles" because of their condylar shape and their presumed function in articulating the plates with the body. The apical portions of the plates are broadened and possess dorsal pubescent cov-

erings of variable density and distribution. The length, density, and distribution of the hair patterns offer excellent differentiating characters. Attempts were made to illustrate all plates with accuracy; in a few species the hair pattern may be slightly overemphasized to aid in their recognition. These broadened apical portions of the plates are referred to as "discs." Occasionally reference is made to a usually petiolate sector between the disc and condyle, termed the "neck" (fig. 86).

Noteworthy is the unique nature of the seventh ventral plates of *C. thoracicus* Smith, a sibling species of *inaequalis*, that is found along the eastern and southern seaboard of the United States. There are a few minor external features by which these species can be separated, but occasionally genitalic examination is necessary. The most interesting feature of *thoracicus* is the fact that it shows striking intraspecific variation in the form of the seventh ventral plates. The plates may be weakly trilobate with the lateral lobes free along the median margins, partially fused to the median lobes, or united completely to form a bilobate apex. This is the only species in which exceptions in these characters have been observed within populations, although subspecific differences occur rather frequently. The material examined shows that the variation occurs at random throughout the range, to such an extent that it is impossible to tell which of the three forms predominates.

## BIONOMICS

The species of *Colletes* are solitary, tending to be semigregarious in selection of their nesting sites, exhibiting, as far as is known from the few kinds studied, species preference for certain soil types and textures.

The conditions believed most primitive are those common to the various groups of species known in America today. The gregarious tendency; the simple, straight nesting tube probably not extending more than a foot below ground level and having the cells in a row; the well-mixed pollen and nectar supplies in each cell; and the complete lining of the nest tunnel with salivary excretions appear to constitute the more basic ancestral characteristics. Unfortunately biological data are so sketchy that one must be overimaginative to attempt even so much as group phylogeny with the material at hand.

*C. inaequalis* Say is the only American colletid on which a creditable amount of information has been accumulated, and from these

data we can assume the species to have undergone considerable evolution from its progenitors.

Several contributions have been made to the biological knowledge of this species of *Colletes,* of which the most outstanding is the work by J. B. Smith (1900, 1901). (The original determination of the species as *C. compacta* by W. J. Fox was in error, as was substantiated by Swenk's re-examination of the Smith material.) Interesting but incomplete information on *C. compactus* Cresson by Phil and Nellie Rau (1916), and on *C. rufithorax* (= *thoracicus* Smith) by Parker and Boving (1924), has shed some light on the biology of these two species but much more observation is necessary before either can be considered to be complete.

Two papers by Friese (1912, 1922) contain summaries of part of the biological knowledge of the Palearctic *Colletes* fauna. Both works deal with *C. daviesanus* Smith, a widespread species of northern and north central Europe and Asia. Malyshev (1923, 1927) and Müller (*In* Noskiewicz, 1936) contributed abundantly to the life history of *C. cunicularius* L., a very close relative of the Nearctic *C. inaequalis.* It is not at all remarkable to find the biologies of these two species almost identical.

An excellent treatise on the biologies of several species of South American *Colletes* is given by Claude-Joseph (1926), and extracts of that paper are presented below.

Some additional data on *C. inaequalis,* obtained by me during the spring of 1951 in Douglas County, Kansas, supplement the Smith paper on the life history of this species. I remain indebted to Dr. Smith for a great deal of that which follows and, to maintain coherence, have omitted the quotation marks where his information was used.

The species was first noted in abundance on the 20th of April in Kansas, a full month later than those observed by Smith. Groups of 15 to 30 mounds of sand and silt were found by chance along the margin of a wheat field in the lowlands along the Kaw River. From the color of the exposed sand and a knowledge of the soil strata, it was calculated some burrows were at least 18 inches deep and that others were in the process of excavation. During the two weeks following the first observation, little mounds appeared in abundance all along the sheltered margin of the field, with few extending into the open adjacent wheat field. Males were noted in great numbers at the time of the first visit, hovering constantly over and about the excavations, but for some obscure reason they would become less

and less obvious towards noon. Very few males were noted in the afternoon but the next morning they reappeared in droves and repeated the violent buzzing about the nests. The earlier the hour, the closer they flew to the ground. It was assumed that the males were awaiting the appearance of emerging females, but during the days which followed no actual coition was observed. During these first few days the females did not leave the nests but would frequently come to the opening and bask in the sun. Occasionally the female would descend and in a few minutes the abdomen would become visible and the hind and middle pairs of legs would violently fling the sand from the entrance. The reaction of the occupants was noted on several occasions where the mouth of the nest had been damaged; and in each instance after the tunnel had been cleared the bee would move up and down, with its mouthparts and fore legs working vigorously close to the tunnel wall as if it were in the process of applying a very thin adhesive. The species is known not to line the tunnel with visible quantities of material, but it may secrete a very fine film to strengthen the walls leading to the cell. Partial verification was obtained on the excavation of a number of nests in which the sandy-silt tunnel walls adhered more closely than the surrounding medium; often pieces of the tunnel could be removed intact.

On the second day of observation the females began gathering pollen and presumably nectar, each trip falling into a similar pattern. The female would project the head and then the thorax slowly, as if in fear of a foe. If a shadow fell across the mouth of the tunnel or the observer moved, the bee hurriedly clambered down the hole and used the head as a plug. Finally, when left undisturbed the bee would emerge, circle the entrance once or twice, and leave for the food source. The return to the nest was usually direct, but on a number of occasions the female would become lost, in which case she would circle the area, often settling and walking over the soil to enter first one, then another burrow. This process was repeated, at times requiring up to 20 minutes, before she found her own nest. There was considerable variation in the time required for a female to secure a load, depending presumably upon the supply of pollen and nectar as well as the distance to the source. One female required 13 minutes to return laden and another took 47, the mean time per trip approximating half an hour. The deposition of the collected food required much less time, some emerging 4 minutes after entering the tube. Again, however, there were great differ-

ences in the time required to emerge. One bee remained in the burrow for 1 hour 5 minutes before reappearing; it was assumed that the female was in the process of sealing a cell and preparing another.

By the 3rd of May many of the burrows were filled in and the flight activity of both sexes had become reduced. Contrary to Smith's observations there was no preponderance of males following the cessation of female activity.

Later, burrows in use were traced, each yielding meagre finds. The first and second tunnels ended barely 12 inches below the surface in partially completed cells and despite continued digging yielded nothing. A third excavation was made on filled-in observation burrows, known to contain good supplies of pollen. The first 22 inches of the tunnel were followed without too much difficulty until the first (actually the last formed) cell was reached. The female had apparently filled the tunnel with light-colored sand surrounding the burrow entrance and the solidly packed yellow sand stood out well in the darker sandy silt. There is evidently no common form to the burrow, for the first 12 inches curved weakly from a vertical orifice and the last 10 inches ran almost parallel to the soil surface. Another curved sharply 3 inches below the surface, ran sub-horizontally for a few inches, and then dropped almost vertically another 18 inches before the first cell was found. Still others curved weakly throughout their length. Below this first cell the path of the tunnel was nowhere evident and excavation was continued by carefully removing layers of soil from an area two feet in diameter. As many as five cells were uncovered from a single burrow, each lying on separate horizons below the last-formed cell, and in no instances were these cells in line. The deepest cell was 34 inches below ground level; cells from the nests examined were separated by as much as 12 inches in a horizontal plane and 5 inches vertically. Smith's statements seem most logical to account for this pattern in *inaequalis*. The bee digs down from the first to the extreme depth of the burrow, then runs off to one side for two to four or rarely six inches, makes and fills a cell, and lays an egg in it. Two or three inches higher another lateral is started, running in a different direction, and the sand taken from this lateral is dropped into the main tube, from there it washes into the first lateral so that when the second is completed the first is well filled. The second lateral is filled with material from the third if a third is run and, finally, the entire tube is filled.

Five of the eleven cells unearthed were undamaged and were taken to the laboratory; three had been torn open in the process of removal, two were infested with ants, and one had desiccated. The cell is approximately 15 mm. in length and 5 mm. in diameter, with the distal end rounded and the proximal end abruptly truncate, at times weakly concave. In texture the capsule, made presumably of salivary secretion, was thin and transparent, tending to show little pliability and tearing easily. It may serve to protect against soil organisms, dirt, and desiccation.

Claude-Joseph states that the viscous substance making up the membrane is secreted by glands at the base of the tongue, under the clypeus. It then descends by vessels to the terminal lobes and opens into the ciliated zone, which spreads it in a fine film.

The food stored in the brood cells is a pasty mixture of nectar and pollen, probably derived from a number of sources visited by the female, e. g., *Cercis canadensis, Salix, Prunus.* The cell is half-filled with food, and the egg, which is large, is attached to one side of the cell by one end and so curved that the opposite tip rests on the surface of the food mass. The egg is slightly more than 3 mm. in length. After the egg is laid, the upper end of the cell is closed by means of a flat disc, which is set in a little from the ragged upper edge. Smith calculates that the interval from the beginning of the burrow until the first egg is laid is from 18 to 20 days.

Two cells were found in which the larvae had just hatched; attempts to rear these to maturity failed. The young larvae retained a position very similar to that of the egg for a long time, with the mouthparts resting on the surface of the soupy food mass. Many of the cells taken up a month after the active flight dates were undoubtedly from the earliest burrows; hence the egg stage is an unusually long one.

On July 1 Smith unearthed four cells in which the larvae were so far developed that they came near to filling the cell. The bulk of the food store had been devoured and growth must have been nearly completed. Unfortunately further samples could not be obtained later in the season, and the date of pupation is thus left undetermined. It is uncertain whether the insects reach the adult stage in the fall and winter in the ground, or whether they winter as mature larvae and change to pupae and adults very early in spring.

Malyshev (1927), working with *C. cunicularius,* reports the following observations on that species: ". . . At the end of July,

July 27, 1917, in the vicinity of Kursk, I found a single cell occupied by *Colletes* which contained an unpigmented pupa. Three other cells were found in Borisowka on July 2, 1917, containing white pupae with pigmented eyes.

"The first young bee was noted in a nest in mid August which I had kept under observation since April. By digging the thawed out earth (March 29, 1916 in Borisowka) I found a matured male. Excavations on April 6, 1917 yielded two cells with females prepared for flight, four cells with mature, living larvae and more earth filled cells from previous years. Thus the development of the larvae was observed. On the 8th of July, 1917 the larva transformed into a pupa and on the 22nd of July, that is two weeks later, it had wings and had transformed into the adult female. The latter overwinters without leaving the cell. *C. cunicularius* overwinters either in a mature stage (which appears to be customary) or in a stadium of the resting larva (diapause). . . ."

In view of the close relationship that exists between *cunicularius* and *inaequalis,* it would not be remarkable to find *inaequalis* exhibiting similar variation in its overwintering form.

Observations on *C. succinctus* L. by Mayet (1875) indicate that the males are first to emerge, and search for the females much as those of *inaequalis.* Once fertilized, the females begin to construct their nests, employing a used burrow or starting at a new site. The sand is loosened with the mandibles and is ejected from the burrow by means of the legs and by curving the abdomen under the body. A gallery may be constructed in a single day when new nests are being formed or in several hours when the bee utilizes an old burrow. The cell is formed as in *inaequalis* and requires eight to ten trips to fill. The bee disgorges the nectar with some force, and a specimen placed in a glass tube dispelled the nectar in a small stream to the end of the tube. After the egg is laid, the cell is closed and covered with several layers of material similar to that which forms the rest of the cell. The larva of this species begins feeding in the fall and continues to develop the following spring. Pupation occurs about the middle of August. The adult bee emerges fifteen days after pupation and remains within the cell for about six days. It then breaks its way into the gallery, where it remains for ten to twelve days before emerging to mate.

*C. daviesanus,* differing greatly from the above, was found by Friese (1912) to tunnel "in vertical sand stone and clay walls. The circular path runs diagonally down in the layer of sand and curls

to one side at the end, reaching almost 10 cm. into the wall. The inner wall of this round burrow is painted with a hardened liquid which upon examination proved to be a very fine spun lining which covers the inner wall of the nest and is then painted with saliva. In this setting the bee deposits the gathered pollen and seals off a single cell with a hyaline lid, which forms the arched base of the following cell; in this way the individual cells form a tube, with one segment projecting into the other. . . . One finds as many as 10 such cells joined in a brood chamber but more often less; other authors have reported 20 cells per brood chamber. . . . The nests, which were formed during the previous July and August, have half-grown larvae by the spring of the next year (March 28). With the advent of warmer weather, the larvae begin to eat the remaining pollen, working from the center to the outside of the cell, and reach their full growth by the middle of May. I observed the first pupae, with only the eyes pigmented on June 11th . . . and by the beginning of July the pupae were further pigmented and hardened so that I expected free flying stages by middle July; however it was July 27th before there were abundant numbers in flight."

Michener (*in litt.*) reports that at Montara, California, *C. fulgidus longiplumosus* Stephen nests in great numbers in banks and that the cells are constructed end to end in the burrows as in *C. daviesanus.*

A few nests were unearthed in the vicinity of Ottawa, Canada, during the summer of 1950 and had the tunnel lined with a material of cellophanelike texture. The species is believed to be *C. kincaidii* Cockerell.

Claude-Joseph's (1926) thorough report on the Chilean species of *Colletes* exemplifies the diverse habits of the genus in that locale. The galleries generally are cylindrical, winding, often branched, and usually deep, with branching or winding characteristic for each species. The cells occupy the ends of the galleries or their branches and may be isolated or deposited in linear series. Linear series of 4 to 8 cells are not uncommon in *araucariae* Friese, *cyanescens* Hal., and *bicolor* Smith, whereas others have pectinate or bifurcate nesting tubes with single cells terminating each short branch. One of the most interesting sites is that of *C. ciliatus* Friese, which is found in the vacated cement abodes of *Odynerus humeralis* or in the dry branches of *Peumus* and *Kageneckia* spp. The cellular membrane is semitransparent and glistening and varies in turgidity with each species. Each cell is constructed completely, except for its cover, before provisioning is begun. Apparently both nectar and pollen

are collected in a single trip, for when the bee returns to the cell the insect turns around so that the abdomen faces the bottom of the cell, and combs the pollen from the posterior femora. It then turns its head about and disgorges the nectar, mixing it little by little to obtain a sweet paste. When the bee has gathered the quantity desired it excavates the surface of the paste and deposits its egg. The larva of *C. araucariae* was observed to move feebly over the surface of the paste, eating slowly into its food, and disappearing within two or three weeks.

Once the egg has been laid the bee begins to form the closing membrane to the capsule. The tongue is touched against the cellular margin and a droplet of a viscous substance is deposited; the bee then lowers its head vertically and pulls up a fine thread across the opening. With continuous to and fro movements across the entrance, it forms a series of threads which transverse it in all ways. The tongue again passes over the threads thus formed, but this time the viscous material oozes from its lobes into the pores of the web, forming a thin membrane over the top of the cell.

The egg hatches within a couple of weeks, depending upon the amount of heat absorbed by the soil. After maturity the larva remains immobile for several weeks, during which digestion and assimilation proceed slowly. Then a period of reactivation sets in and a yellowish fluid flows from its mouth. This substance is spread by the buccal organs all about it and against the cell walls to form a secondary envelope, in which it pupates. The apparent inactivity lasts for the duration of metamorphosis.

Unlike *inaequalis*, the Chilean species never close the galleries that lead to their nests, and at the most gather a few grains of sand in front of the last-formed cell. This condition leaves an open door to a number of hymenopterous and dipterous parasites.

Noskiewicz is obviously in error in stating that all *Colletes* have but one generation per year, for among the American species many have a spring and a fall generation, *e. g.*, *texanus* Cresson, *wickhami* Timberlake, *birkmanni* Swenk, *louisae* Cockerell, *daleae* Cockerell. The presence of spring emergents (*inaequalis* Say, *etc.*), summer emergents (*kincaidii* Ckll., *etc.*), and fall emergents (*compactus* Cress., *etc.*) well fills the seasonal niches available to them.

Of the Nearctic species many are recorded from only one host plant, but considerable field observation is necessary upon most of these for which a single plant record exists. However, for several species there are abundant data, which imply oligolectic tendencies.

I am reasonably certain that the species *C. aestivalis* Patton and *C. andrewsi* Cockerell are oligolectic on the flowers of *Heuchera spp.*, as they have been taken only from *H. americana* and *H. hispida.* Several listed below are also considered oligolectic until subsequent collection information proves otherwise.

*C. albescens* Cresson on *Amorpha; C. distinctus* Cresson on *Ilex; C. ochraceus* Swenk on *Eriogonum; C. wilmattae* Cockerell on *Petalostemon; C. saritensis* Stephen on *Dalea.*

Other species exhibit preference for one or more families of flowers, but the great majority are polylectic, deriving their food from a variety of unrelated plants.

The knowledge of the parasites of Nearctic *Colletes* is very meagre, and only a few records are found in the literature. Parker and Boving's (1924) paper on the life history of *Tricrania sanguinipennis* on *C. rufithorax* is unique in this phase of *Colletes* biology. The principal parasites of *Colletes* spp. are the bees of the genus *Epeolus,* but so sketchy is the information that no idea exists as to the degree of infestation under normal conditions, or any data on their biologies.

Bischoff (1930), reporting on *Epeolus spp.* in the European region, found considerable minor polymorphism among the members of a single species, and says on this topic, "A problem for the future will be to ascertain the existing and failing constancy of our middle European species to the native hosts and to what extent these same species can live on different hosts." He is apparently uncertain of the cause of the polymorphism, stating, "About the minor differences of the individual form, one can be in doubt whether it is a question of food or different host species." Without settling the question raised by Bischoff, Noskiewicz, on the basis of observation, is of the opinion "that in many cases one and the same *Epeolus* species can have different *Colletes* species as hosts."

In addition to the two genera mentioned above, Blair (1920) records the following as parasites of *C. daviesanus* Smith: Diptera; *Bombylius minor* L., *Miltogramma punctata* Meig.: Coleoptera; *Meloe:* Hymenoptera; *Chrysis cyanea* L.

Claude-Joseph reports *Epeloides sp.* and *Isepeolus sp.* as parasites on *C. musculus* Friese; *Isepeolus sp.* and *Anthrax sp.* as parasites on *C. laticeps* Friese. He also lists *Coelioxys* as being a general parasite of this genus.

## DISTRIBUTION AND PHYLOGENY

Generalizations and deductions are always subject to criticism because of their tentative nature. In the absence of fossils the possibility is remote that there can be conclusive substantiation for any phylogenetic "tree" rooted beyond the near past. However, the accumulation of a multitude of implications, meaningful but far from complete, cannot be ignored. An attempt is made to interpret the data at hand without resorting to dogmatic conclusions.

Though some difference of opinion exists concerning the most primitive group of apoids, there is little doubt that members of Paracolletini are the progenitors of the Colletini. The present distribution of this primitive group is panaustral; they are found in temperate South America, Australia, and southern Africa. *Colletes,* however, is found throughout the world with the exception of Anstralia, suggesting that the genus arose after the submergence of the land bridge between Australia and continental Asia, probably during the late Cretaceous. This would still have permitted the genus to originate in Africa, South America, or at some marginal locality of its predecessor, a form presumably similar to *Paracolletes.*

It is frequently possible to ascertain the center of origin of a group, with some reliability, from distribution patterns. However, many genera display a center of variation and species frequency far removed from their point of origin. This appears to be the case in *Colletes,* for though there is a distinct numerical superiority of species in western North America, such diversity is also found in other areas exhibiting similar habitat diversification (Spain, Turkestan). In these areas, the isolation of populations has probably resulted in rapid fixation or even in nonadaptive genetic combinations, which alone would hardly offer suitable evidence from which one could determine a generic center.

The following text includes 108 species and subspecies, the great majority of which are restricted to continental America north of Mexico. Eleven species are known to extend into Mexico, but further collections should reveal upwards of 45 species or subspecies occurring in both the United States and Mexico. Only one species is suspected to be common to the Palearctic and Nearctic regions. This species, *C. impunctatus* Nylander, is found across the northern portions of Asia and Europe, whereas its Nearctic counterpart, *C. impunctatus lacustris* Swenk, appears to be restricted to the Hudsonian and Canadian zones of America. Further consideration is given the problem later in the text.

Adhering closely to distributional patterns of many other Nearctic insects, the species of *Colletes* are most abundant in the diversified habitats west of the 105th meridian. Of the 108 species, 72 are known to occur in this region, approximately 55 being restricted to it. I believe that the majority of species of this region, certainly the *daleae* and *consors* groups, either arose in this region or resulted from a northward migration of parental stock from the Mexican Plateau at some time during the Tertiary.

Noskiewicz' illustrations of the seventh ventral plates of Palearctic *Colletes* show less diversification of basic form than exhibited by Nearctic species; and the derivation of the Palearctic fauna, treated by him, from Nearctic sources is well within the realm of probability. He states: "According to our present knowledge it appears that the genus *Colletes* is much stronger in Asia than Europe or Africa. Of the 123 species worked by me, 54 are purely Asiatic, 20 European, 15 North African: 19 species are Eurasian, 6 Eurafrican, 8 occur in Europe, Asia and Africa and only one species is found exclusively in Africa and Asia. If these numbers are totalled we have 82 [species] in Asia, 53 in Europe and 30 in North Africa." The progressive numerical decrease in species number and the reduction in morphological complexity as one retreats from North America towards Africa lend additional weight to the claim for a New World origin of the genus.

On the same topic it is interesting to note that the *nigricans* group (Noskiewicz), which predominates in the Mediterranean regions, has undergone a tremendous reduction in morphological complexity, particularly in the copulatory structures of the male: the volsellae (fig. 1, plate XIV, Noskiewicz) appear to be absent but are probably greatly reduced; the gonocoxites are simple, composed of what appears to be an uninterrupted segment; the gonostyli are broadly fused to the gonocoxites with no evident line of separation and the seventh ventral plates of the metasoma are weakly lobate, lacking the complexities of the more primitive types.

This group, including all species with unsegmented gonocoxites, is restricted to the regions about the Mediterranean Sea extending from the Canary Islands on the west to Transcaspia on the east. It appears to be superimposed upon a continuum of diverse species having the single common characteristic of segmented gonocoxites. Such a localized group evolving towards lines of greatly increased simplicity near one of the areas harboring the primitive paracolletine

ancestral types would minimize, but not eliminate, the probability of African origin.

There is little doubt in my mind that the major part of the North American *Colletes* fauna originated as successive adaptations of Neotropical forms (i. e., *americanus, simulans, latitarsis, consors,* and *daleae* groups). Their distribution is largely restricted to southern North America. The uniqueness of these groups, the absence of close Palearctic relatives, and the existence of Central American relatives contribute to such a hypothesis.

However, in contrast to these groups there exist groups of related forms occurring in both parts of the Holarctic region. The broadly distributed species of the *inaequalis* group in North America (particularly *inaequalis* Say and *validus* Cresson) have a close morphological and biological resemblance to the groups *formosus, cariniger,* and *cunicularius* as described by Noskiewicz. [A detailed examination of the descriptions of the species in the latter groups as well as the illustrations of the seventh ventral plates for each species convinces me that Noskiewicz has overemphasized the subdivisions at the group level. The three groups, comprising a total of five species, have a continuous, nonoverlapping distribution from Siberia to North Africa; they are, without exception, early spring bees like *C. inaequalis,* and are very close morphologically. It appears that he has used single characters of perhaps no more than subspecific importance to differentiate groups and even subgenera. For example, the three groups mentioned are separated from a close ally, the *acutus* group, on the basis of the length of the malar space, the color of the hind legs and tarsi, absence of abdominal fasciae, and length and density of body pile. I have found none of these characters useful except for species separation. *C. cunicularius,* which resembles *inaequalis* most closely, is found from Siberia to Germany, its subspecies *C. c. infuscatus* Noskiewicz in Spain and Italy; *C. formosus* Pérez is known from Tripoli and Algeria and *C. cariniger* Pérez (seventh plates identical with those of *formosus*) has been taken from Syria and Egypt. In the series of species mentioned there is a progressive loss of the trilobate aspect of the seventh ventral plates with the median lobe undergoing greatest reduction.]

If it is assumed that simplicity and reduction are indicative of recent origin, *inaequalis* Say may be considered the most primitive species of these groups. Its broad distribution throughout the Nearctic region, the polylectic habits of the species, and its stability in

America suggest an invasion of the Palearctic region probably during Tertiary times, giving rise to the members of the four groups listed above.

The reverse seems the case with *C. impunctatus lacustris* Swenk, occurring in the boreal region of North America, and *C. impunctatus impunctatus* Nylander from Siberia, which are so close morphologically that I do not hesitate to reduce the former to a subspecies of the latter. This distribution, unlike that of the *inaequalis-cunicularius* complex, is presently nearly continuous. Here, however, the broad dispersal of forms allied to *impunctatus* from Switzerland and Sweden to India and Siberia, accompanied by the restricted zone occupied by *lacustris* in North America and its lack of close relatives in America, would indicate a migration from Eurasia to North America.

Although I have had little opportunity to examine Old World material, I expect that further investigation will reveal that members of the *hyalinus* group, and possibly others, have Holarctic distribution and that one or perhaps several independent migrations to and from America have taken place during the middle and late parts of the Tertiary.

*Nearctic Distribution:* The distributional patterns of the genus in America are similar to those of a number of other genera. The most common of these patterns is exemplified by the two species complexes *lutzi* and *consors* (maps 6 and 7), which abound in the higher altitudes of California, about the northern edge of the Great Basin, and along the Continental Divide. No doubt the *consors* group, restricted to a montane habitat, follows the migratory path of the Boreal and Transition zones through Colorado and Wyoming, whence it skirts the Great Basin to terminate in the Cascades of Washington and the Sierra Nevada of central California. On the basis of present data *lutzi* follows a pattern similar to that of *consors* from Colorado to California.

A third species, *hyalinus* Provancher, in which three subspecies are recognized, presents a disjunct and confusing pattern. The species, as known to date, occupies the northern plains region of America and the western lowlands of California and Oregon (Map 5). To my knowledge, no continuum exists between *h. hyalinus,* east of the Divide, and either *h. oregonensis* Timberlake or *h. gaudialis* Cockerell on the west, but the resemblance is so apparent that I must agree with Timberlake (1951) when he says, "Renewed study of *C. hyalinus* (*sensu stricto*) and *C. gaudialis* convinces me that

they are similar enough to be races of one species and the probability of intergradation is enhanced by the presence in Oregon and along the coast of northern California of the somewhat intermediate form *C. h. oregonensis.*" Records from Matanuska on the coast of Alaska and White Horse in the Yukon may prove the species to extend up the coast to the north, forming a continuum in the far north. Though this is possible, it appears equally probable that further collections may reveal a continuous cline to extend through a series of river channels and mountain valleys from east to west.

A fourth pattern, apparent in the distribution of the *simulans* group, is thought to have its stem in Mexico. The northerly migration into America follows a three-pronged route from the southern Rocky Mountain region: (1) a northerly mountain route into Colorado and Wyoming, (2) a westerly path into the lowlands of Nevada and California, whence it has migrated as far north as the valleys of British Columbia, and (3) a broad adaptation to the plains regions of America east of the Continental Divide (Map 1).

The region of origin of the *texanus* subgroup is obscure but their close relationship to the rest of the *consors* group would weigh heavily in favor of a thesis supporting their derivation from a Mexican form similar to *consors.* They are without exception restricted to the lower Sonoran zone from western Texas to California.

A number of distribution maps have been included in the present work in an attempt to clarify the ranges of those species in which confusion has already arisen or is likely to arise. In most instances two or more sibling, or closely related, species have been plotted on the same map to illustrate more clearly areas of overlap and limits of the ranges. Other maps have been prepared for species in which subspeciation has given rise to complex patterns, *e. g., simulans* Cresson, *consors* Cresson, *hyalinus.* Known marginal records have been plotted for the more common species. Areas are shaded to indicate the recorded as well as suspected range of the group in question.

A similar procedure has been followed in presenting distributional data in the text. When the range is broad and material abundant, only peripheral localities are noted, but for the less common and new species complete collection information is recorded. For the most part the two recorded extremes serve to delimit the seasonal flight period of the species and where information is available the peak of the flying population is noted.

## GEOGRAPHICAL VARIATION

The observed details of geographical variation among the various species have been recorded under the species. Most of the widespread species seem to vary to some degree geographically; only where the variation is rather obvious and consistent are subspecies recognized. In a few instances subspecies are listed that would probably not have been recognized except for the fact that names had already been applied to them.

There is no obvious consistent association of the variations with geographic or climatic factors. Thus no ecological rules, such as those readily devised for coloration, size, and proporations in various groups of vertebrates, wasps, butterflies, etc., apply consistently to the variations in *Colletes*. Generally, the populations from arid western habitats are paler in ordinary body pile, in the pale covering of the abdomen, and in the wings than their near relatives from more humid areas. *C. consors mesocopus* Swenk and *C. nigrifrons* Titus may be cited as exceptions to this general rule, in which paler forms are found in more humid areas. There are, of course, a few widespread rather invariable species as well.

## MEASUREMENTS

Frequent reference is made to the lengths of the antennal or flagellar segments in both the descriptions and the keys. Unless indicated otherwise, the dorsal surface of any of the medial flagellar segments is taken as a standard.

Considerable difficulty was encountered in measuring the length of the malar space. In all species the width of the malar space is the distance between the anterior and posterior mandibular articulations. For the most part the length is considered to be the distance represented by a perpendicular line running from the anterior mandibular articulation to the compound eye (Figure 85). However, in many species the compound eye is narrowed below, and if the malar space is broad this perpendicular line reaches well up along the inner orbital margin. In such cases the length is taken as the distance between the line joining the mandibular articulations and a parallel line running through the mediobasal corner of the compound eye (Figure 85). The corner is hardly angulate but sharply rounded and distinct.

Measurements of total length and wing length given in descriptions are usually means. Extremes are not indicated for they mean little, especially for the body, where much depends on the degree

of telescoping of the abdomen. In most species the smallest individuals are about 3 millimeters shorter than the largest.

## DESCRIPTION OF THE GENUS

Swenk (1908) has given an excellent account of the history of the name *Colletes* and of its genotype (*C. succinctus* Linnaeus), and Griffin (1935, 1938) has verified information on the dating of the principal works involved.

The subgenera proposed by Cockerell, Friese, and Noskiewicz are for single species or very small groups (up to 3 species) which are aberrant in certain respects. In no way do they represent major divisions of the genus into its principal phyletic lines, but rather are names provided for unusual terminal branches of these lines. As yet the phylogeny of the genus as a whole has not been sufficiently elucidated to make recognition of the principal lines of descent possible. Until this is done, it seems best to synonymize the subgeneric names.

*Colletes* Latreille, 1802, Histoire naturelle des fourmis, p. 423.
Type: *Apis succincta* Linnaeus. Monobasic.
*Evodia* Panzer, 1806, Krit. Rev. Insektenfauna Deutschlands, vol. 2, p. 207.
Type: (*Apis calendarum* Panzer) = *Apis succincta* Linnaeus. Monobasic.
*Colletes* subg. *Rhinocolletes* Cockerell, 1910, Entomologist, vol. 43, p. 242.
Type: *Colletes nasutus* Smith. Monobasic.
*Colletes* subg. *Ptilopoda* Friese, 1921, Stettiner Ent. Zeitung, vol. 82, p. 83.
Type: (*Colletes maculipennis* Friese) = *Colletes spiloptera* Cockerell. Monobasic.
*Colletes* subg. *Denticolletes* Noskiewicz, 1936, Prace Nauk. Wydawnictwo Towarzystwa Nauk. Lwowie, ser. 2, vol. 3, p. 486.
Type: *Colletes graeffei* Alfken. Monobasic.
*Colletes* subg. *Puncticolletes* Noskiewicz, 1936, Prace Nauk. Wydawnictwo Towarzystwa Nauk. Lwowie, ser. 2, vol. 3, p. 490.
Proposed without genotype designation and therefore invalid under article 25 C of International Rules of Zoological Nomenclature.

Head and thorax with pile long and dense; metasomal terga usually fasciate; posterior femora of female with long dense pollen brush; labrum broader than long with median concavity, often delimited by thickenings on either side; subantennal sutures directed towards inner margins of antennal sockets; facial foveae present, most evident in female, of variable width, nonpilose and depressed; galeae short; submentum broad and elongate; labial palpi short, 4-segmented, first segment 1¼ times as long as second, others subequal; glossa short, broad, bifid, strongly emarginate medially; maxillary palpi 6-segmented; eyes concave along inner orbital margins; pre-episternal sutures complete; metanotum horizontal, in same plane as scutellum and basal area of propodeum; propodeum with narrow horizontal basal area, smooth or longitudinally carinate,

posterior face with a 3-cornered, shiny, depressed, nonplumose median area, pointed below; wings hairy; pterostigma large; marginal cell with apex not on wing margin; fore wings with three submarginal cells, first equal to second and third together in length, second and third subequal in length; vein second m-cu at right angles to $Cu_1$ and strongly arcuate outward in posterior portion; pygidial and basitibial plates absent; inner hind tibial spurs strongly toothed or combed; eighth metasomal (ninth abdominal) sternum of male roughly equilaterally triangular; capsule with gonocoxites usually transversely divided (always in Nearctic species); gonostyli usually distinct and pilose apically; gonobase large; penis valves enlarged basally, tapered apically with dorsal and/or ventral "wings"; volsellae large and distinct (in Nearctic species).

## GROUPINGS WITHIN THE GENUS

The morphological uniformity of the genus indicates no obvious major phyletic lines of descent; however, a number of small aberrant groups are readily recognizable. To facilitate the separation and treatment of the members of the genus, the species were placed in natural groups and the groups arranged consecutively in what appears to be a phyletic order of descent.

It is difficult to outline briefly the basis of these divisions, for a multitude of characters are concerned and the resulting group characters would tend to be as exhaustive as the species descriptions. The principal factor influencing the assignment of the species to a group was the structure of the male genitalia; this includes the form of the seventh ventral plates, size and shape of the gonostyli, structure of the penis valves and wings, and shape of the gonocoxites. Secondary group characters include the size of the flagellar segments, size and structure of the clypeus, presence of metapleural prominences, body puncturation, etc. At times one or two characters are sufficient in separating the groups, but for the most part a consideration of the general body morphology is necessary. Because of the last-mentioned point it is believed that the comprehensive treatment necessary for characterizing the groups that follow would not add appreciably to the context.

Groups I to XVI are composed of several closely-related species, and groups XVII to XIX are each represented by a single species. The latter three groups are strongly divergent and show little resemblance to any of the groups preceding them. It might have been

covered. For the sake of uniformity this was not done, and the groups are listed in the order of their appearance in the text. A desirable feature would have been a key to the groups. This, however, would have been unsatisfactory from the standpoint of species separation, for in the vast majority of cases there were no obvious group characters that could be directly applied to a workable key. I feel that such a key would add to the complexity rather than ease the burden of determination.

The groups and their component species are as follows:

Group I *productus*
- *productus* Robertson
- *arizonensis* Stephen
- *cercidii* Timberlake
- *rudis* Timberlake
- *perileucus* Cockerell
- *gilensis* Cockerell
- *skinneri* Viereck
- *vandykei* Timberlake

Group II *compactus*
- *compactus* Cresson

Group III *latitarsis*
- *latitarsis* Robertson
- *punctipennis maurus* Stephen

Group IV *simulans*
- *simulans* Cresson
- *angelicus* Cockerell
- *fulgidus* Swenk
- *rufocinctus* Cockerell
- *louisae* Cockerell
- *bryanti* Timberlake
- *birkmanni* Swenk
- *slevini* Cockerell
- *eulophi* Robertson
- *kincaidii* Cockerell
- *trigonatus* Cockerell
- *utilis* Cockerell
- *delodontus* Viereck
- *wootoni* Cockerell

Group V *aestivalis*
- *aestivalis* Patton
- *andrewsi* Cockerell

Group VI *robertsonii*
- *robertsonii* Dalla Torre
- *metzi* Timberlake
- *timberlakei* Stephen
- *larreae* Timberlake
- *turgiventris* Timberlake
- *kansensis* Stephen

Group VII *nudus*
- *nudus* Robertson
- *carolinus* Mitchell
- *brimleyi* Mitchell

Group VIII *americanus*
- *americanus* Cresson
- *annae* Cockerell
- *laticinctus* Timberlake
- *bradleyi* Mitchell
- *mitchelli* Stephen
- *ochraceus* Swenk
- *tectiventris* Timberlake
- *gypsicolens* Cockerell
- *albescens* Cresson
- *aberrans* Cockerell
- *howardi* Swenk
- *susannae* Swenk
- *saritensis* Stephen
- *thysanellae* Mitchell
- *wilmattae* Cockerell
- *micheneri* Stephen
- *mandibularis* Smith
- *solidaginis* Swenk

Group IX *hyalinus*
- *hyalinus* Provancher
- *lutzi* Timberlake
- *distinctus* Cresson
- *phaceliae* Cockerell

| | |
|---|---|
| Group X *inaequalis* | |
| *inaequalis* Say | *validus* Cresson |
| *thoracicus* Smith | |
| Group XI *impunctatus* | |
| *impunctatus lacustris* Swenk | |
| Group XII *willistoni* | |
| *willistoni* Robertson | *brevicornis* Robertson |
| Group XIII *consors* | |
| *consors* Cresson | *wickhami* Timberlake |
| *paniscus* Viereck | *chamaesarachae* Cockerell |
| *nitescens* Timberlake | *scopiventer* Swenk |
| *californicus* Provancher | *texanus* Cresson |
| *nigrifrons* Titus | *swenki* Stephen |
| *xerophilus* Timberlake | *linsleyi* Timberlake |
| *sphaeralceae* Timberlake | |
| Group XIV *intermixtus* | |
| *intermixtus* Swenk | *bulbotibialis* Stephen |
| Group XV *ciliatus* | |
| *ciliatus* Patton | *ciliatoides* Stephen |
| *beamerorum* Stephen | |
| Group XVI *daleae* | |
| *daleae* Cockerell | *deserticola* Timberlake |
| *algarobiae* Cockerell | *petalostemonis* Swenk |
| *clypeonitens* Swenk | *prosopidis* Cockerell |
| *covilleae* Timberlake | *solitarius* Timberlake |
| *salicicola* Cockerell | |
| Group XVII *aridus* | |
| *aridus* Stephen | |
| Group XVIII *titusensis* | |
| *titusensis* Mitchell | |
| Group XIX *longifacies* | |
| *longifacies* Stephen | |

## KEY TO THE MALES

To facilitate the separation of the species, three of the most distinctive natural groups are removed in the first three couplets. It would have been desirable to separate each of the nineteen groups in this manner, but this proved impractical, for there are no distinctive characters applicable to all of the species within each group.

Couplets 1, 2, and 3 require some explanation, as many of the species of these large natural groups (*americanus* group, *consors* group, and *daleae* group) removed by these couplets are not always recognizable by one or two obvious characters. Unfortunately, in both keys several species that have a striking resemblance in the critical key characters have been taken out with the *americanus* and *consors* groups, although they are not members of these groups. This was done to facilitate the separation of species in which key

characters are likely to be confusing. It should be noted that all species foreign to but occurring in the couplets stated to be members of the *americanus* or *consors* groups are also found elsewhere in the key. The following explanatory material is therefore provided:

Forms which should go to couplet 70 (*americanus* group) exhibit the following characters: malar spaces no longer than broad; flagellar segments one and one-quarter to one and three-quarters times as long as broad; clypeus uniformly curved and densely punctate with striate or ovate punctures; propodeum with the lateroposterior margins abrupt or ridged, not rounded; pile of body all light; seventh ventral plates with discs quadrate to weakly triangular; penis valves with narrow ventral wings; gonostyli short, triangular.

Forms which should go to couplet 88 (*consors* group) exhibit the following characters: malar spaces no longer than seven-eighths as long as broad; flagellar segments short, about as long as broad; propodeum with basal area narrow and sloping rather sharply ventrally, lateral and posterior faces finely striate and roughened, rounded at lateroposterior margins; pile of body long and dusky grey, often intermixed with black on head and thorax; seventh ventral plates roughly quadrate, or reduced to short transverse discs; penis valves with broad dorsal and ventral wings; gonostyli short, roughly triangular.

Forms which should go to couplet 108 (*daleae* group) exhibit the following characters: malar spaces at least as long as broad; flagellar segments at least as long as broad; clypeus elongate with longitudinal median sulcus bordered by lateral shiny, sparsely punctate rims; sulcus densely punctate, rims sparsely punctate with round punctures; propodeum with basal area smooth and broad, usually not sharply pitted but with a few weak longitudinal rugae, lateral and posterior faces shiny with numerous fine punctures; body covered with long white pile; species all small, less than 9 mm. in length, found only in western part of the Great Plains and Lower Sonoran zone of North America; seventh ventral plates quadrangular or weakly modified to triangular, discs covered with fine short pile; penis valves with only ventral wings, wings small; gonostyli virtually absent, evident as slightly expanded apical processes.

1. Metapleura each with dorsal prominence or horizontal carina, usually with testaceous rim, and malar spaces no longer than broad (Flagellar segments longer than broad) ..... 70

Metapleura with no dorsal prominence or if weakly prominent with carinae curving ventrally well in front of posterior

margins, if having rimmed prominence then malar spaces one and one-half times as long as broad ..... 2

2(1). Median flagellar segments usually as long as broad or slightly longer, and penis valves with broad dorsal and ventral wings, 88

Median flagellar segments usually at least one and one-half times as long as broad; if shorter, penis valves lacking dorsal wing ..... 3

3(2). Clypeal punctures sparse and round and clypeus with longitudinal median sulcus; propodeum with basal area broad and smooth, occasionally with a few weak longitudinal rugae ..... 108

Clypeal punctures elongate, at least apically, or, if not, clypeus without any indication of a sulcus; propodeum with basal area deeply pitted ..... 4

4(3). Mesoscutum, scutellum, or inner orbital margins with varying amounts of black pile ..... 5

Mesoscutum, scutellum, and inner orbital margins with pile all light ..... 29

5(4). Malar spaces at least as long as broad, usually longer ..... 6

Malar spaces no longer than three fourths as long as broad ..... 12

6(5). Malar spaces at least one and three-fourths times as long as broad; mesepisterna dull and roughened (Prothoracic spines absent) ..... *validus*

Malar spaces less than one and one-half times as long as broad; mesepisterna punctate with shiny interspaces ..... 7

7(6). Metasomal sterna two to four emarginate medially; pile of body dusky; malar spaces slightly longer than broad (Tergal fasciae very weak and dusky) ..... *impunctatus lacustris*

Metasomal sterna two to four with posterior margins entire; pile of body white to tawny; malar spaces one to one and one-half times as long as broad ..... 8

8(7). Mesepisterna dull and roughened, obscurely punctate ..... 9

Mesepisterna coarsely punctate with shiny interspaces ..... 10

9(8). Propodeum with posterior face outside of triangle rugose above; metasomal terga with discs having abundant short, erect, black pile; thorax with pile long, dense, and ochreus; seventh ventral plates with lateral lobe short and at times partially fused to median (fig. 56) ..... *thoracicus*

Propodeum with posterior face outside of triangle dull and roughened; metasomal terga with discs having pile white to pale grey; thorax with pile long, fine, and pale grey on periphery; seventh ventral plates tripartite apically, lateral lobes long and broadly separated from median lobe (fig. 55) ..... *inaequalis*

10(8). Inner orbital margins with admixture of black pile (Malar spaces one and one-quarter times as long as broad; clypeus with deep median longitudinal sulcus and impunctate lateral rims) ..... *compactus*

Inner orbital margins with pile all light ..... 11

11(10). Malar spaces one and three-eighths times as long as broad; seventh ventral plates laterally quadrate with long latero-basal "tail" and distinct neck (fig. 7) (Metasomal terga one and two coarsely and densely, almost contiguously, punctate) ..... *skinneri*

Malar spaces as long as broad; seventh ventral plates longitudinally quadrate, lacking necks between discs and articulatory condyles, discs about twice as long as broad (fig. 19), *bryanti*

12(5). Posterior basitarsi short, no more than two and one-half times as long as broad ..... 13

Posterior basitarsi about four times as long as broad ..... 15

13(12). First metasomal tergum shiny, weakly folliculated (with a distinct metallic blue lustre); posterior basitarsi two and one-half times as long as broad ..... *intermixtus*

First metasomal tergum densely punctate with shiny interspaces, punctures about one puncture width apart; posterior basitarsi two times as long as broad ..... 14

14(13). Wings pictured; neotropical, reaching southern Texas, *punctipennis maurus*

Wings not pictured; American Great Plains ..... *latitarsis*

15(12). Dorsolateral fringes of propodeum with strong admixture of black pile ..... 16

Dorsolateral fringes of propodeum with pile all light ..... 17

16(15). Length 8.5 mm.; mesepisterna with pile exclusively light; metasomal tergum one sparsely and finely punctate on anterior median face ..... *arizonensis*

Length 13.5 mm.; mesepisterna with abundant black pile on upper faces; metasomal tergum one uniformly densely punctate, punctures no more than one puncture width apart, *vandykei*

17(15). Prothoracic spines long and sharp, at least as long as width across bases ..... 18

Prothoracic spines short, vestigial or obliquely truncate ..... 24

18(17). Vertex and mesoscutum with abundant black pile; length 11-14 mm. (Body coarsely punctate) ..... 19

Vertex with pile all light; mesoscutum with but few black hairs; length 8-10 mm. ..... 20

19(18). Metasomal tergum two with sharp basal depression; metasomal tergum one deeply, almost contiguously, punctuate; clypeus striately punctate with shiny interspaces ..... *gilensis*

Metasomal tergum two not depressed basally; metasomal tergum one shiny, punctures deep but separated by at least one and one-half puncture widths; clypeus deeply, contiguously punctate with no shiny interspaces ..... *nudus*

20(18). Propodeum with posterior face shiny, striately rugose, forming deep pits dorsally outside of triangle; seventh ventral plates with discs twice as broad as long, apices broadly concave (fig. 33) ..... *carolinus*

Propodeum with posterior face dull and roughened or smooth and shiny; seventh ventral plates with discs at least as long as broad ..... 21

21(20). Propodeum with basal area flat and smooth with few longitudinal rugae, not at all quadrately pitted; metasomal tergum one shiny, impunctate ..... *perileucus*

Propodeum with basal area deeply quadrately pitted; metasomal tergum one finely punctate ..... 22

22(21). Metasomal tergum one finely and sparsely punctate, punctures one and one-half to two puncture widths apart; seventh ventral plates short, roughly triangular (fig. 51) ..... *hyalinus*

Metasomal tergum one coarsely and densely punctate, punctures no more than one puncture width apart; seventh ventral plates elongate, at least twice as long as broad, quadrate ..... 23

23(22). Penis valves with ventral wings truncate apically, coterminal with valve apices; seventh ventral plates quadrate with apical margins strongly expanded, almost lobate (figs. 12, 13, 14) ..... *simulans*

Penis valves with ventral wings narrowed apically, weakly pointed; seventh ventral plates quadrate with apices broadly rounded, not lobate (fig. 16) ..... *fulgidus*

24(17). Prothoracic spines obliquely truncate with posterior margins extending beyond anterior (Second metasomal tergum with weak basal fascia) ..... *angelicus*

Prothoracic spines short or absent, not truncate ..... 25

25(24). Propodeum with posterior face shiny, striately rugose, forming deep pits dorsally outside of triangle ..... 26

Propodeum with posterior face dull and roughened, not striate or pitted outside of triangle ..... 27

26(25). Seventh ventral plates laterally extended, median and lateral margins strongly reflexed; discs of plates about twice as broad as long (fig. 33); malar spaces three-quarters as long as broad ..... *carolinus*

Seventh ventral plates elongate, at least twice as long as broad with strong laterobasal projections (fig. 16); malar spaces five-eighths as long as broad ..... *fulgidus*

27(25). Mesepisterna dull and roughened, punctures obscure; sternal fasciae weak and incomplete ..... *inaequalis*

Mesepisterna coarsely punctate with shiny interspaces, punctures about one-half puncture width apart; sternal fasciae complete, dense, and white ..... 28

28(27). Propodeum quadrately pitted with deep shiny pits outside of triangle; black pile restricted to a few black hairs on scutellum; mesepisterna weakly rugosely punctate; seventh ventral plates roughly quadrate (fig. 4) ..... *rudis*

Propodeum with basal area smooth, not pitted outside of triangle; black pile abundant on mesoscutum and scutellum; mesepisterna coarsely punctate with shiny interspaces; seventh ventral plates broadly triangular with apical margins broadly rounded (fig. 3) ..... *cercidii*

29(4). First metasomal tergum shiny, impunctate, or, if punctate, with a few scattered folliclelike punctures especially laterally .... 30
First metasomal tergum closely punctate, punctures no more than two puncture widths apart ..... 42

30(29). Eyes with inner orbital margins nearly parallel (Mesepisterna and metasomal terga dull, obscurely punctate) ..... 31
Eyes with inner orbital margins strongly convergent below (First flagellar segment no more than one-half as long as second) ..... 32

31(30). Posterior basitarsi very long and broad, about two and seven-eighths times as long as broad; prothoracic spines absent; length 13-15 mm. ..... *andrewsi*
Posterior basitarsi long and narrow, about four times as long as broad; prothoracic spines short and sharp; length 11-12 mm. ..... *aestivalis*

32(30). Malar spaces at least as long as broad ..... 33
Malar spaces shorter, no more than three-quarters as long as broad ..... 34

33(32). Metapleura protuberant above with narrow black rim; propodeum coarsely rugose with large pits on posterior and lateroposterior faces outside of triangle ..... *productus*
Metapleura not protuberant above; propodeum finely roughened, not pitted outside of triangle ..... *hyalinus*

34(32). Propodeum coarsely rugose, roughened, forming large pits on upper posterior face outside triangle; mesepisterna coarsely rugosely punctate ..... 35
Propodeum finely roughened or smooth outside triangle, never pitted; mesepisterna deeply punctate with shiny interspaces, 37

35(34). Flagellar segments short, as long as broad; malar spaces linear ..... *titusensis*
Flagellar segments about one and one-half times as long as broad; malar spaces at least three-eighths as long as broad, 36

36(35). Malar spaces three-fourths as long as broad; seventh ventral plates with discs broader than long, weakly quadrate (fig. 34) ..... *brimleyi*
Malar spaces three-eighths as long as broad; seventh ventral plates longer than broad, roughly triangular (fig. 53), *distinctus*

37(34). Flagellar segments about as long as broad (Seventh ventral plates with discs transverse and narrow, sharply excavated apically (fig. 75)) ..... *aridus*
Flagellar segments at least one and one-half times as long as broad ..... 38

38(37). Penis valves with broad dorsal and ventral wings; seventh ventral plates elongately rectangular, twice as long as broad (fig. 67) ..... *wickhami*
Penis valves lacking dorsal wing; seventh ventral plates never longer than wide ..... 39

39(38). Prothoracic spines short or vestigial; nervures light brown; length 11-14 mm. ..... 40
Prothoracic spines sharp, at least as long as width across base; nervures dark brown to black; length 8.5-9.5 mm. ..... 41

40(39). Malar spaces two-thirds as long as broad; metasomal terga impunctate ..... *larreae*
Malar spaces one-half as long as broad; metasomal terga with sparse coarse punctures ..... *turgiventris*

41(39). Propodeum with basal area deeply quadrately pitted; metasomal tergum one sparsely punctate; terga shiny black; metasomal fasciae weak and narrow; head and thorax with pile fuscous and sparse (Length 8.5 mm.) ..... *hyalinus*
Propodeum with basal area nearly smooth, not pitted; metasomal tergum one impunctate; terga shiny blue-back; metasomal fasciae dense and white; head and thorax with pile white ..... *perileucus*

42(29). Malar spaces linear to one-fourth as long as broad; metasomal terga closely, often contiguously, punctate to lateral margins (Apical fasciae in abrupt declivous depressions) ..... 43
Malar spaces at least one-third as long as broad; metasomal terga variable, never contiguously punctate ..... 47

43(42). Prothoracic spines at least as long as width across base; pile of head and thorax long and white; metasomal tergum one coarsely punctate ..... 44
Prothoracic spines short or absent; pile of head and thorax short, dense, and tinged with ochreus; metasomal tergum one very finely punctate ..... 46

44(43). Seventh ventral plates transverse, apical margins broadly excavated and fringed with long, light ochreus pile (fig. 27), *robertsonii*
Seventh ventral plates with apical margins expanded or complex ..... 45

45(44). Seventh ventral plates with basal portions transverse as in *robertsonii* but with transverse lobes attached to medio-apical processes (fig. 30) ..... *metzi*
Seventh ventral plates with apical margins expanded, tending to membranous, plates roughly quadrate, narrowed laterally (fig. 31) ..... *timberlakei*

46(41). Mesepisterna dull, shallowly obscurely punctate, especially below; seventh ventral plates fully semilunar (fig. 72); tegulae light hyaline; penis valves with ventral membranous wings absent except for small preapical piece ..... *ciliatus*
Mesepisterna distinctly punctate with shiny interspaces; seventh ventral plates narrowed, almost sickle-shaped (fig. 73); tegulae deep brown; penis valves with broad ventral wings, *beamerorum*

47(42). Posterior basitarsi short, about two and three-fourths times as long as broad and curved longitudinally; posterior tibiae expanded medially, constricted towards base and apex (Clypeus long, flat, shiny, sparsely and finely punctate; seventh ventral plates roughly triangular with apices sharply emarginate (fig. 71)) ..... *bulbotibialis*
Posterior basitarsi at least three and one-half times as long as broad and straight; posterior tibiae not constricted apically, 48

48(47). Metasomal tergum two uniform from base to apex, not depressed basally ..... 49
Metasomal tergum two depressed basally, with or without basal fascia ..... 50

49(48). Mesoscutum and scutellum with dense covering of ochreus to yellow pile, obscuring surface; mesepisterna dull, roughened; malar spaces three-fourths as long as broad .... *thoracicus*
Mesoscutum and scutellum with pile white to tawny; mesepisterna coarsely punctate with shiny interspaces; malar spaces one-half as long as broad ..... *turgiventris*

50(48). Malar spaces at least seven-eighths as long as broad ..... 51
Malar spaces no more than three-fourths as long as broad ..... 60

51(50). Metasomal tergum one with punctures deep, punctures about one puncture width apart or less ..... 54
Metasomal tergum one with punctures fine, shallow, and separated by at least two puncture widths ..... 52

52(51). Prothoracic spines sharp, length at least one and one-half times width across base ..... 53
Prothoracic spines short, triangular (Wings whitish hyaline; seventh ventral plates with discs cordate and with laterobasal projection at bases of discs and necks (fig. 18)) ... *louisae*

53(52). Seventh ventral plates as long as broad, roughly triangular; gonostyli about as long as width across base (fig. 51) .. *hyalinus*
Seventh ventral plates with discs twice as long as broad, roughly quadrate with lateral margins broadly rounded; gonostyli two and one-half times as long as broad (fig. 21), *slevini*

54(51). Malar spaces long, about one and one-fourth times as long as broad (Metasomal terga with discs covered with white or light-grey pile; tegulae light ochreus hyaline) ..... *wootoni*
Malar spaces about as long as broad, or shorter ..... 55

55(54). Seventh ventral plates short and broad, about as broad as long; gonostyli no longer than broad ..... 56
Seventh ventral plates at least twice as long as broad; gonostyli two and one-half times as long as broad ..... 58

56(55). Malar spaces as long as broad; metasomal tergum two strongly depressed basally with weak basal fascia (Seventh ventral plates with discs slightly broader than long, surface with uniform covering of fine pubescence (fig. 54)) ..... *phaceliae*
Malar spaces no longer than three-fourths as long as broad; metasomal tergum two with no basal fascia ..... 57

57(56). Length 8 mm.; body densely covered with long white pile; seventh ventral plates with lateral hair bands strongly developed and broadly united to median band basally (fig. 51); lowland species ..... *hyalinus*
Length 7 mm.; body with pile sparse and grey; seventh ventral plates with lateral hair bands weakly developed, not broadly united to median band basally, pile of lateral bands short (fig. 52); montane species ..... *lutzi*

58(55). Seventh ventral plates with distinct petiolate necks between discs and articulatory condyles ..... 59

Seventh ventral plates lacking necks between discs and condylar articulations, discs broadly united to condyles (fig. 19) (Mesepisterna densely, coarsely, contiguously punctate above; body with pile usually strongly tinged with ochreus) ..... *bryanti*

59(58). Seventh ventral plates with abrupt lateral shoulders at latero-basal margins of discs, strongly emarginate beneath (fig. 23) ..... *kincaidii*

Seventh ventral plates uniformly curved about lateral margins of discs (fig. 22) ..... *eulophi*

60(50). Seventh ventral plates with discs as broad as long; gonostyli short, no more than one and one-half times as long as width across the bases ..... 61

Seventh ventral plates with discs twice as long as broad, roughly quadrate; gonostyli long and slender, two and one-half times as long as width across base ..... 64

61(60). Malar spaces one-third as long as broad; penis valves with narrow dorsal wings; gonostyli broader than long (fig. 74), *ciliatoides*

Malar spaces at least one-half as long as broad; penis valves with no dorsal wings; gonostyli about one and one-half times as long as broad ..... 62

62(61). Metasomal tergum two with weak basal fascia; seventh ventral plates with discs slightly broader than long, lateral margins broadly rounded, discs with uniform covering of fine pubescence (fig. 54) ..... *phaceliae*

Metasomal tergum two with no basal fascia; seventh ventral plates with discs roughly triangular, lateral margins straight, discs with pile most dense along lateral and median margins ..... 63

63(62). Body densely pilose with long white pile; seventh ventral plates with lateral hair bands well developed and broadly united to median bands basally, pile of lateral bands long (fig. 51); lowland species ..... *hyalinus*

Body with pile sparse and tawny to white; seventh ventral plates with lateral hair bands weakly developed, not united to median band basally, pile of lateral bands short (fig. 52); montane species ..... *lutzi*

64(60). Prothoracic spines vestigial, triangular or obliquely truncate at apex ..... 65

Prothoracic spines long and sharp, at least as long as width across base ..... 69

65(64). Prothoracic spines obliquely truncate with posterior margins extending beyond anterior (Metasomal tergum two with weak basal fascia; seventh ventral plates with strong latero-basal projections (fig. 15)) ..... *angelicus*

Prothoracic spines sharply pointed or vestigial ..... 66

66(65). Malar spaces three-fourths as long as broad; wings whitish hyaline with little pubescence; metasomal tergum one with few coarse punctures, at least two puncture widths apart on disc (Seventh ventral plates with long necks between discs and condyles, discs cordate with laterobasal projections at junction of discs and necks (fig. 18)) ..... *louisae*

Malar spaces less than five-eighths as long as broad; wings dusky with abundant testaceous pubescence; metasomal tergum one distinctly punctate with punctures one and one-half puncture widths apart ..... 67

67(66). Seventh ventral plates elongate, roughly ovate with short neck and lacking laterobasal projection (fig. 20) ..... *birkmanni*

Seventh ventral plates elongate, roughly quadrate, with no neck between discs and condyles ..... 68

68(67). Metasomal tergal discs four to six with long, erect, light pile; metasomal terga one and two with apical fasciae narrow and weak; seventh ventral plates lacking laterobasal projections (fig. 17) ..... *rufocinctus*

Metasomal tergal discs four to six with erect fuscous to black pile; metasomal terga one and two with apical fasciae broad and dense; seventh ventral plates with strong laterobasal projections (fig. 16) ..... *fulgidus*

69(64). Seventh ventral plates elongate, roughly ovate, weakly shouldered but with no laterobasal projections (fig. 20) .... *birkmanni*

Seventh ventral plates elongate, roughly quadrate, expanded apically with strong laterobasal projections (figs. 12, 13, 14), *simulans*

70(1). Lower edge of metapleural prominence with a broad rim which hangs down and obscures surface beneath it in lateral view ..... 75

Lower edge of metapleural prominence weakly protuberant with a narrow rim which projects laterally ..... 71

71(70). Seventh ventral plates transverse, narrow, with long, dense apical fringe of fuscous pile (fig. 29); tegulae black; metapleural prominence abrupt, heavily rugose including rim, *kansensis*

Seventh ventral plates roughly quadrate in form; tegulae light brown hyaline; metapleural prominence weakly protuberant, not rugose ..... 72

72(71). First metasomal tergum impunctate or weakly punctate medially ..... 73

First metasomal tergum densely punctate (Malar spaces three-fourths as long as wide; abdomen and thorax with pile dusky to yellow; length 10-11 mm.) ..... *howardi*

73(72). Vertex and mesoscutum with admixture of black pile; hypoepimeral area abruptly protuberant; flagellar segments short, about as long as broad ..... *thysanellae*

Vertex and mesoscutum with pile all light ..... 74

74(73). Malar spaces three-fourths as long as broad; body covered with long, dense, white pile; seventh ventral plates quadrangular, weakly rounded laterally (fig. 40); length 9-10 mm., *gypsicolens*

Malar spaces one-third as long as broad; body covered with short, sparse, dusky pile; seventh ventral plates almost square (fig. 58); length 7-8 mm. ..... *mitchelli*

75(70). First metasomal tergum with disc distinctly punctate, punctures no more than three puncture widths apart at mid-line, 76

First metasomal tergum with disc impunctate and shiny, or, if punctate, punctures weak and sparse and folliclelike ..... 81

76(75). Femora, tibiae, and tarsi yellow testaceous (Mesepisterna distinctly punctate with shiny interspaces; metasomal terga two to five with discs having abundant erect ferrugineous pile) ..... *wilmattae*

Femora and tibiae dark or largely so, tarsi occasionally tinged with yellow ..... 77

77(76). Anterior edge of pronotum raised and protruding as an erect plate, most evident as an abrupt process above the coxal bases; prothoracic tergum very broad with anterior and posterior edges raised slightly to form a broad, weakly convex tergum (Prothoracic spines absent) ..... *aberrans*

Anterior edge of pronotum flat, tergum narrow and flat ..... 78

78(77). Flagellar segments short, about one to one and one-fourth times as long as wide; first metasomal tergum with disc deeply punctate, punctures no more than two puncture widths apart at mid-line ..... 79

Flagellar segments long, at least one and one-half times as long as wide; first metasomal tergum with punctures three puncture widths apart at mid-line, one puncture width apart laterally (Prothoracic spine long; nervures dark brown), *mandibularis*

79(78). Second metasomal tergum with broad basal fascia; first metasomal tergum densely and uniformly punctate, punctures no more than one puncture width apart ..... 80

Second metasomal tergum with no basal fascia; first metasomal tergum with disc coarsely punctate, punctures about two puncture widths apart; prothoracic spine short and sharp; nervures deep brown ..... *saritensis*

80(79). Prothoracic spines long and sharp, at least as long as width across bases; pile of body tinged with ochreus; North Carolina ..... *howardi*

Prothoracic spines very short or absent; pile of body pure white; Great Plains ..... *susannae*

81(75). Malar spaces as long as broad; first metasomal tergum impunctate ..... *albescens*

Malar spaces no more than three-fourths as long as broad; first metasomal tergum variable ..... 82

82(81). Mesoscutum with punctures mesad from parapsidal lines, shallow and at least two puncture widths apart ..... *micheneri*
Mesoscutum with punctures mesad from parapsidal lines, no more than one puncture width apart (Mesepisterna with punctures coarse and dense on upper half) ..... 83

83(82). Wings whitish hyaline with pubescence light ..... 84
Wings dusky with abundant dusky pubescence ..... 86

84(83). Seventh ventral plates roughly quadrangular with apical margins broadly rounded, pilose on median and lateral reflexed faces; malar spaces three-eighths as long as broad (fig. 50), *laticinctus*
Seventh ventral plates quadrate with apical margins truncate; variably pilose; malar spaces one-fourth as long as broad ... 85

85(84). Propodeum with basal area sloping sharply ventrally, not pitted but having irregular longitudinal rugae; seventh ventral plates longer than the width from median to lateral extremities, plates quadrate with narrow hyaline nonpilose area at the latero-basal margins (fig. 37) ..... *tectiventris*
Propodeum with basal area not sloping sharply ventrally, broadly quadrately pitted; seventh ventral plates short, slightly broader than long with lateral margins weakly rounded and pilose (fig. 36) ..... *annae*

86(83). Rims of metapleural prominences narrow and testaceous; seventh ventral plates with discs extended laterally, about two and one-half times as broad as long (fig. 49) .... *solidaginis*
Rims of metapleural prominences broad and testaceous; seventh ventral plates with discs roughly quadrate, never more than one and one-half times as broad as long (fig. 35) ..... 87

87(86). Mesepisterna coarsely contiguously punctate on upper half; pile of body dense, partially concealing surface; southern coastal areas of California ..... *ochraceus*
Mesepisterna with punctures above, separated by narrow, roughened, shiny interspaces; pile of body sparse, not concealing the surface; America east of Continental Divide ..... *americanus*

88(2). Face with black pile intermixed along inner orbital margins; legs with strong admixture of black or fuscous pile ..... 89
Face with pile white to tawny grey; legs with pile white to pale grey (except *c. consors*) ..... 92

89(88). Prothoracic spine long and sharp; mesepisterna with pile entirely black; metasomal terga with no apical fasciae .. *californicus*
Prothoracic spine short or vestigial; mesepisterna with pile pale grey; metasomal terga with white apical fasciae at least on first two segments ..... 90

90(89). Legs and discs of metasomal terga three to six with abundant erect black pile ..... 91
Legs and discs of metasomal terga three to six with pile white to pale grey ..... *paniscus paniscus*

91(90). Malar spaces one-half as long as broad; mesoscutum and scutellum with pile tawny grey, no dark hairs intermixed; seventh ventral plates roughly quadrate, densely covered with long, laterally directed pile ..... *consors pascoensis*

Malar spaces three-fourths as long as broad; mesoscutum and scutellum with pile tawny, intermixed with a few black or dark hairs on the disc; seventh ventral plates with apical margins broadly rounded, laterobasal margins weakly pointed, plates with transverse median bands of pile. (fig. 62) ..... *paniscus*

92(88). First metasomal tergum coarsely and densely punctate, punctures no more than one puncture width apart; mesoscutum coarsely, densely, almost contiguously punctuate ..... 93

First metasomal tergum with punctures fine or absent, when present, punctures at least two puncture widths apart, surface at times roughened and punctures obscure ..... 102

93(92). Metapleura weakly protuberant above, protuberance strongly rugose; body coarsely and densely punctate; metasomal terga with discs having abundant short erect black pile ..... 94

Metapleura not protuberant above; body variably punctate, punctures not uniformly coarse over entire body; metasomal terga with discs having covering of light pile ..... 98

94(93). Clypeus short, strongly convex; flagellar segments one and one-third times as long as broad; length 12-14 mm. ..... 95

Clypeus flattened on median suface; flagellar segments as long as broad; length 8-10 mm. ..... 97

95(94). Seventh ventral plates transverse, apical margins broadly excavated and fringed with long, light ochreus pile (fig. 27), *robertsonii*

Seventh ventral plates with apical margins expanded or complex ..... 96

96(95). Seventh ventral plates with basal portions transverse as in *robertsonii* but with transverse lobes attached to medio-apical processes (fig. 30) ..... *metzi*

Seventh ventral plates with apical margins expanded, tending to membranous, plates roughly quadrate, narrowed laterally (fig. 31) ..... *timberlakei*

97(94). Metasomal terga one to three with distinct narrow preapical grooves followed by raised flangelike margins; antennal segment three one and one-half times as long as four; malar spaces linear ..... *brevicornis*

Metasomal terga one to three with apex smooth, not grooved; antennal segment three subequal to four; malar spaces one-third as long as broad ..... *willistoni*

98(93). Malar spaces at least one-half as long as broad, usually longer; mesepisterna coarsely punctate with shiny interspaces ..... 99

Malar spaces no more than one-third as long as broad; mesepisterna finely and shallowly punctate or rugosely punctate above ..... 100

99(98). Prothoracic spines long and needlelike, at least twice as long as width across the base; malar spaces seven-eighths as long as broad ..... *texanus*
Prothoracic spines short and sharp, roughly triangular; malar spaces one-half as long as broad ..... *wickhami*

100(98). Posterior basitarsi four and one-fourth times as long as broad; penis valves lacking dorsal wing (fig. 73); vertex finely and densely punctate ..... *beamerorum*
Posterior basitarsi three and one-quarter times as long as broad; penis valves with broad dorsal wing; vertex impunctate or very sparsely punctate ..... 101

101(100). Propodeum with lateral faces shiny, obscurely punctate; basal area of propodeum shallowly pitted, sloping sharply basally; first metasomal tergum with median line of disc shiny and impunctate; seventh ventral plates long and roughly quadrate with apical end narrowed and having long fringes of pile (fig. 66) ..... *sphaeralceae*
Propodeum with lateral faces dull, weakly striate; basal area of propodeum with deep quadrate pits not sloping sharply ventrally; first metasomal tergum without shiny impunctate longitudinal mid-line; seventh ventral plates short, semilunar, with apices broadly rounded (fig. 65) ..... *nigrifrons*

102(92). Metasomal terga with apical and basal fasciae absent (Malar spaces one-third as long as broad; propodeum with lateral and posterior faces dull and weakly roughened), *xerophilus cismontanus*
Metasomal terga with fasciae broad and grey to white ..... 103

103(102). Tibiae and tarsi with strong admixture of black and fuscous pile; seventh ventral plates square with apical margins weakly rounded, long pile over disc except on extreme median margins (fig. 61) ..... *consors consors*
Tibiae and tarsi with pile white or tawny; seventh ventral plates semilunar or elongately rectangular ..... 104

104(103). Metasomal terga three to six with discs having abundant erect black or fuscous pile ..... 105
Metasomal terga three to six with discs having pile white or pale grey ..... 106

105(104). First metasomal tergum shiny impunctate, or sparsely and finely folliculated; seventh ventral plates small, roughly quadrate with apex broadly rounded, discs densely covered with long, laterally sloping pile (fig. 61) ..... *consors mesocopus*
First metasomal tergum shiny, distinctly punctate with punctures one to two puncture widths apart; seventh ventral plates diamond-shaped with median and lateral margins reflexed, sparsely covered with short erect pile (fig. 63) ..... *nitescens*

106(104). Mesoscutum and scutellum with admixture of black pile; mesepisterna very coarsely and densely punctate; punctures no more than one-half puncture width apart above, almost contiguous (Seventh ventral plates broad with large membranous apical expansion (fig. 68)) ..... *swenki*

Mesoscutum and scutellum with pile entirely light; mesepisterna with punctures variable, fine, not contiguous, separated by shiny interspaces ..... 107

107(106). Flagellar segments as long as broad; first metasomal tergum and mesepisterna with discs distinctly punctate, punctures one-half puncture width apart on mesepisterna .... *nigrifrons*

Flagellar segments one and one-fourth times as long as broad; first metasomal tergum shiny, virtually impunctate except for shallow scattered punctures; mesepisterna with punctures about one puncture width apart on discs ..... *xerophilus*

108(3). Malar spaces about one and one-eighth times as long as wide or shorter ..... 109

Malar spaces at least one and one-half times as long as wide ... 111

109(108). Antennae with flagellum light brownish yellow beneath; flagellar segments less than one and one-half times as long as broad (Clypeus closely punctate on basal portion with broad, shiny, impunctate areas on either side of mid-line; length 6.5-7.5 mm.; seventh ventral plates quadrate with apical margins sloping basally towards median edge (fig. 82)) ..... *prosopidis*

Antennae with flagellum dark brownish black or reddish brown beneath; flagellar segments more than one and one-half times as long as wide ..... 110

110(109). Mesepisterna with discs deeply punctate, punctures about one puncture width apart; metasomal terga black with reddish tinge, second and third metasomal terga with very broad apical fascial depressions; seventh ventral plates broadened apically and abruptly truncate with inner apical margins strongly reflexed (fig. 76); malar spaces broad, slightly longer than broad; clypeus long with broad, shiny, impunctate areas on either side of the mid-line ..... *algarobiae*

Mesepisterna with discs having punctures two puncture widths apart; seventh ventral plates broadened and rounded apically (fig. 83); malar spaces narrow, slightly shorter than broad; clypeus short and closely punctate across base, shiny areas on either side of mid-line with coarse, scattered punctures ..... *deserticola*

111(108). Seventh ventral plates with apical margins convex ..... 112

Seventh ventral plates with apical margins truncate or slightly concave (Far western and southwestern) ..... 113

112(111). Mesepisterna with disc deeply punctate, punctures less than one puncture width apart; nervures of hind wing light, almost yellowish; seventh ventral plates shorter, apices more strongly convex (fig. 81); western part of Great Plains, *petalostemonis*

Mesepisterna with disc more finely punctate, punctures more than one puncture width apart; nervures of hind wing brown; seventh ventral plates longer, apices less strongly convex (fig. 79); southwestern deserts ..... *salicicola*

113(111). Malar spaces at least twice as long as broad; flagellar segments strongly tinged with yellow beneath; tarsi black (Flagellar segments about twice as long as wide; clypeus with deep median sulcus, densely and finely punctate; seventh ventral plates much as in *algarobiae*, slightly expanded apically and broadly rounded with long lateral and median fringes of hair (fig. 77); length 8.5-9.5 mm.) ..... *clypeonitens*

Malar spaces approximately one and one-half times as long as broad; flagellar segments strongly tinged with ferrugineous beneath; tarsi variable ..... 114

114(113). Flagellar segments approximately one and three-fourths times to twice as long as broad; metasomal terga black tinged with testaceous at apical fascial depressions; length 8-9 mm., 115

Flagellar segments approximately one and three-eighths times as long as broad; metasomal terga strongly tinged with blue to give discs bluish black lustre; length 7 mm. (Seventh ventral plates short with lateral fringes of pile as well as a long clump of pile arising at upper lateral face immediately beneath articulatory condyle (fig. 80)) ..... *daleae*

115(114). Seventh ventral plates long, expanded and slightly rounded at apex, about twice as long as wide (fig. 79); second metasomal tergum with disc deeply punctate, punctures about two puncture widths apart; length 8 mm. ..... *salicicola*

Seventh ventral plates slightly expanded apically, apex truncate, about one and one-fourth times as long as wide (fig. 78); second metasomal tergum with disc smooth, shiny, and impunctate; length 8 mm. ..... *covilleae*

## KEY TO THE FEMALES

As in the males, further material is submitted to facilitate the separation of couplets 1, 2, and 3. Parallelisms in one or another of the key characters are exhibited by many species that are not members of the groups in question. The ensuing remarks are therefore provided.

Forms which should go to couplet 57 (*americanus* group) exhibit the following characters: malar spaces no more than one-half as long as broad; clypeus densely punctate, punctures striate to ovate; prothoracic spines short and sharp; flagellar segments about three-fourths as long as broad; propodeum with lateroposterior margins abrupt or ridged, not rounded; pile of body usually white to dusky to tinged with ochreus.

Forms which should go to couplet 76 (*consors* group) exhibit the following characters: malar spaces no longer than one-half as long as broad; clypeus variably punctate, punctures ovate to striate; flagellar segments short, about one-half as long as broad, sometimes slightly longer; propodeum with basal area narrow and sloping

sharply ventrally, lateral and posterior faces finely striate and roughened, lateroposterior margins rounded; pile of body long and dusky, often intermixed with black on head and thorax.

Forms which should go to couplet 95 (*daleae* group) exhibit the following characters: malar spaces no longer than three-fourths as long as broad; clypeus usually elongate with longitudinal median sulcus bordered by lateral, shiny, sparsely punctate rims; median sulcus densely punctate, rims sparsely punctate with round punctures; flagellar segments at least three-fourths as long as broad, usually much longer; propodeum with basal area smooth and broad, usually not sharply pitted but with a few weak longitudinal rugae, lateral and posterior faces shiny with numerous fine punctures, lateroposterior margins rounded; pile of body long and white; species small, less than 10 mm., and found only in western parts of the Great Plains and Lower Austral zone.

1. Metapleura each with dorsal prominence or horizontal carina usually with testaceous rim; malar spaces no longer than one-half as long as broad; last exposed sternum with apex not depressed ..... 57
   Metapleura with no dorsal prominence, or, if weak prominence, with carina curving ventrally well in front of posterior margins; if having metapleural prominence then malar spaces as long as broad ..... 2
2(1). Median flagellar segments short, usually one-half to three-fourths as long as broad when viewed from above; *and* last exposed sternum with apical portion strongly depressed with basal arcuate band of overhanging pile; when apical depression very small, sterna with strong scopa ..... 76
   Median flagellar segments usually as long as broad when viewed from above; last exposed sternum usually lacking depressed apical portion ..... 3
3(2). Clypeal punctures sparse and round, and clypeus with longitudinal median sulcus (sulcus not evident in some specimens of *algarobiae*); propodeum with basal area broad and not distinctly quadrately pitted ..... 95
   Clypeal punctures elongate, at least apically, or, if not, clypeus lacking median sulcus; propodeum with basal area usually deeply pitted ..... 4
4(3). Mesoscutum and/or scutellum with admixture of black pile ... 5
   Mesoscutum and scutellum with no black pile ..... 34
5(4). Malar spaces at least three-fourths as long as broad ..... 6
   Malar spaces usually one-half as long as broad or less ..... 10
6(5). Malar spaces one and three-eighths times as long as broad (Metasomal tergum one coarsely punctate; mesepisterna dull, finely roughened; length 11-13 mm.) ..... *validus*
   Malar spaces no longer than broad ..... 7

7(6). First metasomal tergum coarsely and densely punctate, punctures no more than one puncture width apart (Propodeum with basal area very narrow, obscurely pitted) ..... *skinneri*
First metasomal tergum shiny, impunctate or sparsely folliculated ..... 8

8(7). Prothorax with dorsal lateral margins rounded, not spined; propodeum with dorsal and posterior faces dull and roughened, lateroposterior margins rounded .... *impunctatus lacustris*
Prothorax with short, sharp spines; propodeum with dorsal and posterior faces shiny and weakly pitted, lateroposterior margins angulate, separated by weak, elevated carinae ..... 9

9(8). Vertex with pile all light, occasionally a few dark hairs intermixed; metapleura with weak prominences above, prominences with narrow testaceous rims; tegulae light brown, *longifacies*
Vertex with numerous dark hairs intermixed; metapleura weakly protuberant above but without testaceous rims; tegulae dark brown to black ..... *productus*

10(5). First metasomal tergum very finely punctate, punctures follicle-like and at least two puncture widths apart on discal area .. 11
First metasomal tergum deeply punctate, punctures one to one and one-half puncture widths apart laterally, or punctures fine and contiguous ..... 21

11(10). Last metasomal sternum with elevated carinae curved mesad apically; first metasomal tergum with apical margin abrupt and rounded, fascia arising as apical fringe (Prothoracic spines short and sharp) ..... *arizonensis*
Last metasomal sternum uniform; first metasomal tergum with apex flattened and fascial hairs arising subapically ..... 12

12(11). Prothoracic spines short and obliquely truncate with anterior margins extending beyond posterior (Malar spaces one-fifth as long as broad) ..... *rufocinctus*
Prothoracic spines pointed, not truncate ..... 13

13(12). Mesoscutum and scutellum with pile long, dense, and erect, sparsely intermixed with dark hairs; mesepisterna with shiny interspaces above; procoxal spines short, about as long as broad ..... *hyalinus*
Mesoscutum and scutellum with light pile restricted to peripheral portions, abundant black pile intermixed over discal areas; mesepisterna closely or contiguously punctate and roughened; procoxal spines variable ..... 14

14(13). Second metasomal tergum with basal fascia ..... 15
Second metasomal tergum without basal fascia ..... 17

15(14). Procoxal spines absent; propodeum with basal area longitudinally striate, not quadrately pitted ..... *perileucus*
Procoxal spines at least as long as wide; propodeum with basal area deeply quadrately pitted ..... 16

16(15). Wings whitish hyaline; vertex with pile all light; second metasomal tergum shiny, almost impunctate, laterally except for few follicles; clypeus striately punctate with broad shiny

interspaces becoming larger basally; mesepisterna coarsely and rugosely punctate above with no interspaces evident . . *louisae*

Wings dusky hyaline; vertex with weak admixture of black pile; second metasomal tergum shiny, finely punctate with punctures about one and one-half puncture widths apart; clypeus closely, striately punctate to apex; mesepisterna densely and rugosely punctate but with evident interspaces on anterior faces . . . . . *fulgidus*

17(14). Malar spaces one-half as long as broad; mesepisterna coarsely, contiguously punctate (Length 11-13 mm.) . . . . . *carolinus*

Malar spaces no more than one-third as long as broad; mesepisterna coarsely punctate with shiny interspaces . . . . . 18

18(17). Metasomal sterna coarsely and sparsely punctate, punctures at least two puncture widths apart, sterna with sparse, short, erect pile and broadly interrupted apical fasciae . . . . *perileucus*

Metasomal sterna dull, finely punctate, sterna lacking apical fasciae . . . . . 19

19(18). Clypeus short, strongly convex, densely punctate to apex; sterna with dense scopa; compound eyes very large and broad; malar spaces linear . . . . . *titusensis*

Clypeus long, flattened or sulcate medially, sparsely punctate with shiny interspaces; malar spaces one-fourth to one-third as long as broad . . . . . 20

20(19). Clypeus with deep longitudinal median sulcus, extending from base to apex; prothoracic spines very short and sharp; malar spaces one-third as long as broad . . . . . *intermixtus*

Clypeus not sulcate medially, but flattened; prothoracic spines at least as long as width across base; malar spaces one-fourth as long as broad . . . . . *chamaesarachae*

21(10). Last metasomal sternum with raised lateral longitudinal ridges extending to apex . . . . . 22

Last metasomal sternum simple, undifferentiated . . . . . 23

22(21). Prothoracic spines short and sharp; second metasomal tergum abruptly depressed basally; lateral ridges of last sternum weak and arcuate . . . . . *arizonensis*

Prothoracic spines vestigial; second metasomal tergum not depressed basally; lateral ridges of last sternum strong and straight . . . . . *compactus*

23(21). Posterior basitarsi twice as long as broad (Clypeus flattened, obscurely striately punctate; malar spaces one-third as long as broad) . . . . . *latitarsis*

Posterior basitarsi at least three times as long as broad, usually longer . . . . . 24

24(23). Prothoracic spines long and sharp, longer than width across base of spine . . . . . 25

Prothoracic spines short, absent or obliquely truncate, never terminating in a needlelike point to edge of head . . . . . 29

25(24). Fore coxae with long spines, at least as long as broad . . . . . 26

Fore coxae lacking spines . . . . . 27

26(25). Scutellum striately punctate; prothoracic spines long and sharp, protruding to sides of head; first metasomal tergum closely punctate, punctures approximately one puncture width apart ..... *simulans*
Scutellum coarsely punctate, punctures not at all striate; prothoracic spines sharp, not protruding to sides of head; first metasomal tergum with punctures sparse and weak .... *fulgidus*

27(25). Clypeus long, flat, dull, and roughened; flagellar segments short, about five-eighths as long as broad ..... *willistoni*
Clypeus short, convex, coarsely punctate with shiny interspaces; flagellar segments about as long as broad ..... 28

28(27). Malar spaces linear; propodeum strongly ridged on upper posterior face outside of triangle; apical fasciae narrow and weak, often absent medially ..... *nudus*
Malar spaces one-third as long as broad; propodeum with posterior face dull and roughened outside of triangle; apical fasciae broad, dense, and white ..... *gilensis*

29(24). Procoxal spines long, at least three times as long as broad .... 30
Procoxal spines vestigial or absent ..... 31

30(29). Prothoracic spines obliquely truncate, with posterior margins extending beyond anterior; first metasomal tergum with abundant long erect ochreus pile ..... *angelicus*
Prothoracic spines short, blunt to truncate with anterior margins extending beyond posterior; first metasomal tergum with little discal pile except for short lateral fringes .. *rufocinctus*

31(29). Antennae very short, flagellar segments one-half as long as broad; length 9-10 mm. ..... 32
Antennae long, flagellar segments as long as broad; length 12-14 mm. ..... 33

32(31). Metasomal terga one to three with distinct narrow preapical groove, followed by raised flangelike margins; clypeus closely punctate ..... *brevicornis*
Metasomal terga one to three with apical margins entire and smooth, broadly fasciate; clypeus flat, dull, and weakly roughened ..... *willistoni*

33(31). Mesepisterna dull, roughened, obscurely punctate; first metasomal tergum with punctures close and dense, no more than one puncture width apart; metasomal fasciae weak and tinged with ochreus ..... *inaequalis*
Mesepisterna shiny, deeply and coarsely punctate with punctures about one-half puncture width apart; first metasomal tergum finely punctate with punctures about one puncture width apart; metasomal terga tinged with metallic blue; metasomal fasciae broad, dense, and white ..... *cercidii*

34(4). Prothoracic spines sharp, at least as long as width across base .. 35
Prothoracic spines short or absent, never as long as width across base ..... 47

35(34). First metasomal tergum shiny with few scattered fine punctures; terga never covered or partially obscured with appressed pubescence ..... 36

First metasomal tergum distinctly punctate, punctures about one and one-half puncture widths apart; terga often covered or partially obscured by appressed pubescence . . . . . 39

36(35). Last metasomal sternum with weak, elevated lateral longitudinal carinae curved medially at apex; tegulae black, *distinctus*

Last metasomal sternum lacking carinae . . . . . 37

37(36). Second metasomal tergum uniform, with very narrow, inconspicuous white basal fascia, most evident laterally; first metasomal tergum with a few weak folliclelike punctures, *hyalinus*

Second metasomal tergum weakly depressed basally with broad basal fascia; first metasomal tergum variably punctate, punctures usually coarse . . . . . 38

38(37). First metasomal tergum with apical fascial margin not depressed medially; metasomal terga five and six with pile of discs light ochreus to golden; first metasomal tergum shiny, a few coarse punctures scattered over surface . . . . . *birkmanni*

First metasomal tergum with apical fascial margin abruptly depressed throughout its breadth; metasomal terga five and six with pile of discs deep fuscous to black; first metasomal tergum with punctures concentrated on median discal area, *slevini*

39(35). Malar spaces linear; body very coarsely, contiguously punctate; metasomal terga one and two with punctures as coarse as those on mesoscutum . . . . . *robertsonii* and *timberlakei*

Malar spaces one-third as long as broad; body variably punctate; metasomal terga one and two with punctures much finer than those of mesoscutum . . . . . 40

40(39). Metasomal tergum three without basal fascia; metasomal terga four and five with discs having deep fuscous to black pile; scutellum coarsely punctate over posterior three-fourths, weakly striate on anterior half . . . . . 41

Metasomal tergum three with basal fascia; metasomal terga four and five with discs having tawny to ochreus pile; scutellum shiny, sparsely punctate . . . . . 46

41(40). Second metasomal tergum with deep basal depression and weak white fascia, depression deepest medially; malar spaces about one-half as long as broad . . . . . 42

Second metasomal tergum shallowly or not depressed basally with weak white fascia; malar spaces less than one-half as long as broad . . . . . 43

42(41). First metasomal tergum with apex abruptly depressed, disc shiny, finely and sparsely punctate with punctures two to four puncture widths apart . . . . . *slevini*

First metasomal tergum not strongly depressed apically, disc densely and coarsely punctate to apex, with punctures one puncture width apart . . . . . *wootoni*

43(41). Scutellum with anterior half weakly, longitudinally striate or punctate to edge; first metasomal tergum finely punctate with punctures one to two puncture widths apart, *hyalinus gaudialis*

Scutellum with anterior one-third nonpunctate, nonstriate; first metasomal tergum with punctures uniformly dense, no more than one puncture width apart ..... 44

44(43). Length 8-9 mm.; metasomal terga one and two punctate with interspaces dull; montane species from southern California, *lutzi pinorum*

Length 10-12 mm.; metasomal terga one and two punctate with shiny interspaces ..... 45

45(44). Sternal discs rather dull, with a few fine punctures; mesepisterna with punctures separated, about one puncture width apart; northern and western species ..... *kincaidii*

Sternal discs shiny and usually coarsely punctate, punctures about one and one-half puncture widths apart; mesepisterna with punctures closer and almost contiguous on upper half; southern half of United States ..... *eulophi*

46(40). Length 9 mm.; clypeus with sparse, coarse longitudinal punctures to apex; second metasomal tergum densely punctate with punctures about as coarse as those of tergum one; antennal segments about as long as broad ..... *phaceliae*

Length 7 mm.; clypeus with apical one-half shiny impunctate laterally; second metasomal tergum finely folliculated, dull; antennal segments two-thirds as long as broad..... *lutzi*

47(34). Eyes with inner orbital margins nearly parallel; mesepisterna dull, shallowly, obscurely punctate ..... 48

Eyes with inner orbital margins strongly convergent below; mesepisterna shiny to variable ..... 49

48(47). Posterior basitarsi three and one-half times as long as broad; mesoscutum with pile ochreus; length 13 mm.; western part of Great Plains ..... *andrewsi*

Posterior basitarsi four and one-fourth times as long as broad; mesoscutum with pile tawny; length 11 mm.; eastern seaboard ..... *aestivalis*

49(48). Metapleura strongly protuberant above, protuberances with narrow black rims; malar spaces as long as broad .... *productus*

Metapleura not protuberant above; malar spaces less than three-fourths as long as broad..... 50

50(49). Mesepisterna dull, obscurely or finely and densely punctate; mesoscutum with pile bright ochreus ..... 51

Mesepisterna rugosely punctate with shiny, although sometimes roughened, interspaces; pile variable in color ..... 52

51(50). First metasomal tergum finely and densely punctate, punctures one-half puncture width apart; tergal fasciae complete and white; length 11 mm. ..... *ciliatus*

First metasomal tergum shiny impunctate to sparsely folliculated; tergal fasciae absent or evident only as lateral fringes; length 14-15 mm. ..... *thoracicus*

52(50). Apical metasomal sternum with posterior half sharply depressed, apex hyaline nonplumose with long pile overhanging depressed area ..... 53
Apical metasomal sternum simple, not longitudinally differentiated or with weak lateral longitudinal ridges ..... 54

53(52). Malar spaces linear; metasomal terga two and three with no evident basal fasciae; nervures and stigma dark brown to black ..... *turgiventris*
Malar spaces half as long as broad; metasomal terga two and three with weak basal fasciae; nervures and stigma brown, *larreae*

54(52). First metasomal tergum coarsely and densely punctate, punctures no more than one puncture width apart ..... 55
First metasomal tergum shiny, sparsely punctate or finely folliculated ..... 56

55(54). Metasomal tergum two deeply depressed basally throughout; malar spaces one-half as long as broad; posterior tibiae with pile light ..... *wootoni*
Metasomal tergum two shallowly depressed basally, depression not evident medially; malar spaces one-third as long as broad; posterior tibiae with admixture of black pile ..... *bryanti*

56(54). Last metasomal sternum with weak, elevated lateral longitudinal carinae curved medially at apex; second metasomal tergum finely and densely folliculated; tegulae black ..... *distinctus*
Last metasomal sternum lacking carinae; second metasomal tergum sparsely folliculated; tegulae brown hyaline ..... *brimleyi*

57(1). Mesoscutum covered with short, dense, plumose pubescence giving the surface a mosslike mat appearance ..... 58
Mesoscutum covered with moderately long pile, not dense and crowded to conceal surface ..... 60

58(57). Anterior edge of pronotum raised and protruding as an erect plate, most evident as an abruptly protruding plate above the coxal bases; pronotum very broad; metapleural prominence with broad testaceous rim ..... *aberrans*
Anterior edge of pronotum not protruding as an erect plate above the coxal bases; metapleural prominence with narrow testaceous or dark brown rim ..... 59

59(58). Metasomal terga one to five covered with short, dense, appressed pubescence concealing the surface; legs yellow to light brown-yellow apically from trochanters; western part of Great Plains ..... *wilmattae*
Metasomal terga one to five not completely covered with appressed pubescence, a narrow prefascial area on each disc free from pile; legs reddish brown, tending to darker brown basally; metapleural prominence weakly protuberant with a narrow dark brown rim; known only from North Carolina, *howardi*

60(57). Wings whitish hyaline, bare or covered with short white pubescence ..... 61
Wings dusky hyaline, covered with short, deep ochreus to dusky pubescence ..... 64

61(60). First metasomal tergum with disc finely and closely punctate, punctures shallow and about one puncture width apart on lateral faces; metasomal terga with short, sparse, appressed pubescence over surface ..... *susannae*
First metasomal tergum shiny impunctate or finely follic-ulated laterally with follicles at least two follicle widths apart; metasomal terga with at most the basal half covered with appressed pubescence ..... 62

62(61). Malar spaces one-half as long as wide; mesepisterna and mesoscutum with discs deeply and coarsely punctate, punctures no more than one puncture width apart ..... *albescens*
Malar spaces one-fourth as long as wide or less; mesepisterna and mesoscutum with discs obscurely punctate ..... 63

63(62). Metasomal terga one to four covered with short, dense, appressed pubescence, completely concealing the surface, *tectiventris*
Metasomal terga one to four with discs bare except for basal fascia of second metasomal tergum ..... *micheneri*

64(60). Metasomal terga one to four covered with short, appressed pubescence completely concealing the surface ..... 65
Metasomal terga with discs bare, or partially covered with semierect pile not concealing the surface ..... 67

65(64). Mesepisterna shiny and distinctly punctate, punctures at least one puncture width apart; mesoscutum sparsely, shallowly punctate; metasomal terga with pubescence sparse but complete and appressed (Pile of head and thorax yellow), *solidaginis*
Mesepisterna dull, coarsely punctate with punctures almost contiguous; mesoscutum with punctures coarse, about one puncture width apart; metasomal terga with pubescence dense over entire surface ..... 66

66(65). Pile of head and thorax ochreus; wings dusky hyaline with abundant ochreus pubescence over surface; metapleural prominence with rim variable but usually narrow and testaceous; length 9-10 mm. ..... *ochraceus*
Pile of head and thorax pale ochreus to dusky grey; wings with sparse, light ochreus pubescence; nervures light yellow-brown; metapleural prominence with rim narrow, black to deep brown; length 8-9 mm. ..... *tectiventris*

67(64). Metapleural prominence strongly protuberant with a broad rim, abruptly declivous beneath ..... 68
Metapleural prominence weakly protuberant with narrow brown to black rim, shallowly concave beneath ..... 71

68(67). Tegulae black; fascial foveae with upper margins curved strongly mesad, extending two-thirds of the way to lateral ocelli from eyes; mesoscutum with pile dusky grey .... *saritensis*
Tegulae brownish hyaline; fascial foveae with upper margins rounded (not curved) mesad, extending less than half way to lateral ocelli from eyes; mesoscutum with pile tinged with ochreus ..... 69

69(68). Second metasomal tergum with broad, dense basal fascia, at least as broad as nonpubescent area between basal and apical fasciae; first metasomal tergum finely and densely punctate especially laterally; metasomal terga three to five with short, white, semierect pile, giving the surface a whitish sheen; apical fasciae broad and white; lateral fringes of first metasomal tergum dense and continuous to apical fascia; mesoscutum with pile white to ochreus . *mandibularis*

Second metasomal tergum with basal fascia weak or absent, not more than one-third as wide as nonpubescent area between basal and apical fasciae; first metasomal tergum with disc sparsely folliculated and shiny; metasomal terga three to five bare and shiny, occasionally with a few semierect hairs; apical fasciae weak and narrow; first metasomal tergum with lateral fringes weak and usually not continuous to apical fascia; mesoscutum with pile deep ochreus to yellow, 70

70(69). Second metasomal tergum with no basal fascia; mesepisterna coarsely and shallowly punctate with shiny interspaces; propodeum with posterior face traversed by numerous rugae; pile of body sparse, pale grey ..... *bradleyi*

Second metasomal tergum with a narrow basal fascia; mesepisterna densely, almost contiguously, punctate; propodeum with posterior face smooth, sparsely punctate; pile of body tinged with fuscous ..... *americanus*

71(67). Mesoscutum and scutellum with strong admixture of black and dark hairs; second metasomal tergum with no basal fascia; mesepisterna rugose ..... *thysanellae*

Mesoscutum and scutellum with pile entirely light; second metasomal tergum with strong basal fascia; mesepisterna distinctly punctate ..... 72

72(71). Anterior coxae with spines rudimentary; posterior basitarsi about three and one-fourth times as long as broad, *laticinctus*

Anterior coxae with spines well developed; posterior basitarsi four to five times as long as broad ..... 73

73(72). Posterior basitarsi five and one-fourth times as long as broad; mesepisterna densely and contiguously punctate, with a dense covering of long, fine, tawny to white pile; length 12 mm. ..... *gypsicolens*

Posterior basitarsi four times as long as broad; mesepisterna with punctures separated by shiny interspaces below; pile short and not obscuring surface, usually tinged with yellow, 74

74(73). Second and third metasomal terga with distinct basal fasciae; wings with nervures light yellow-brown; antennae tinged with yellow ..... *annae annae*

Second metasomal tergum with weak basal fascia, fascia absent on third; wings with nervures deep brown; antennae dark brown ..... 75

75(74). Mesepisterna with upper half finely, densely, contiguously punctate, almost roughened; mesoscutum and scutellum with pile tinged with deep ochreus; America east of Continental Divide ..... *mitchelli*

Mesepisterna sharply punctate, punctures separated by broad shiny interspaces; mesoscutum and scutellum with pile tawny to tinged with yellow; southern California and extreme southwestern United States ..... *annae disseptus*

76(2). Inner orbital margins, mesepisterna, and upper genal areas with pile black or with admixture of black pile ..... 77

Inner orbital margins, mesepisterna, and upper genal areas with pile white or pale grey ..... 85

77(76). Pile of mesepisterna black ..... 80

Pile of mesepisterna, especially upper half, white to tawny grey (Face with abundant white pile about antennal bases) .. 78

78(77). Metasomal terga with apical fasciae absent; vertex with pile light to dusky; southern California ..... *xerophilus cismontanus*

Metasomal terga with apical fasciae present; vertex with pile variable ..... 79

79(78). Mesoscutum and scutellum with pile all light; pile of face, vertex, and genal areas predominantly black, *paniscus paniscus*

Mesoscutum and scutellum with admixture of black or dark pile; pile of face, vertex, and genal areas predominantly white ..... *xerophilus xerophilus*

80(77). Prothoracic spine long and distinct, at least one and one-half times as long as width across the base (Pile of head, thoracic pleura, and legs black; metasomal fasciae absent) ..... *californicus*

Prothoracic spine absent or vestigial ..... 81

81(80). Mesoscutum and scutellum with strong covering of pale grey to light ochreus pile ..... 82

Mesoscutum and scutellum with admixture of black pile ..... 83

82(81). Metasomal terga two to five with apical fasciae very weak but discernible at lateral margins; mesoscutum and scutellum with pile white to pale grey; propodeum with pile white, *consors consors*

Metasomal terga two to five with no apical fasciae; mesoscutum and scutellum with pile light ochreus; propodeum with strong admixture of black pile ..... *consors pascoensis*

83(81). Metasomal terga one to five with dense white apical fasciae at least laterally; malar spaces one-third as long as wide; metasomal terga one and two finely punctate, punctures one to two puncture widths apart ..... *nigrifrons*

Metasomal terga one to five with fasciae absent, at times evident laterally on tergum one; malar spaces one-half as long as wide; metasomal terga one and two sparsely folliculated ..... 84

84(83). Metanotum and mesoscutum with strong admixture of black pile medially ..... *paniscus mertensiae*

Metanotum and mesoscutum with few scattered black hairs, *paniscus sculleni*

85(76). First metasomal tergum densely punctate or folliculated with punctures one to two puncture widths apart ..... 86

First metasomal tergum impunctate or finely and sparsely folliculated ..... 89

86(85). Metasomal terga one and two with distinct narrow preapical grooves followed by raised flangelike margins (Metasomal terga coarsely and densely punctate) ..... *brevicornis*
Metasomal terga one and two with apical margins smooth .... 87

87(86). Clypeus long, flattened medially with a very faint longitudinal median sulcus; prothoracic spines long, needlelike, about one and one-half times as long as width across the base, *texanus texanus*
Clypeus short, uniformly convex, shiny; prothoracic spines short, triangular ..... 88

88(87). Large robust species, 14 mm.; metasomal terga one to three coarsely and densely punctate, apical fasciae in sharply declivous, nonpunctate depressions .. *robertsonii* and *timberlakei*
Smaller species, 7-8 mm.; metasomal tergum one more densely punctate than two or three, apical fasciae not in marked depressions ..... *linsleyi*

89(85). Last metasomal sternum with the apical one fourth or less depressed; body with pile short and white with few black hairs intermixed; fascial foveae strongly depressed above..... 90
Last metasomal sternum with apical one half strongly depressed; body with pile long, sparse, and dusky; fascial foveae weakly depressed above..... 92

90(89). Mesoscutum and scutellum with discs having strong admixture of black pile, at least one half of pile black..... *swenki*
Mesoscutum and scutellum with pile light, a few dusky hairs intermixed (Clypeus short, convex, shiny, very sparsely, coarsely punctate) ..... 91

91(90). Fascial foveae broad above, extending over half way from eyes to lateral ocelli; some short black pile over mesoscutum, *scopiventer*
Fascial foveae narrow above, extending about one third of way from eyes to lateral ocelli; black pile restricted to few hairs on scutellum ..... *aridus*

92(89). Metapleura with a few dark hairs on upper faces; head very broad, about one and one-third times as broad as long (Metasomal terga two and three finely and densely punctate or coarsely folliculated with shiny interspaces; California) ..... *nitescens*
Metapleura with pile white; head about one and one-fifth times as broad as long or less..... 93

93(92). Clypeus coarsely, contiguously, striately punctate to apex; mesepisterna coarsely and densely punctate above, punctures one-half puncture width apart; fascial foveae obscure, median margins not discernible, dorsal margins extending barely above upper inner orbital margins; tegulae black; California ..... *sphaeralceae*
Clypeus irregularly punctate with shallow, obscure punctures, weakly rugose and shiny; mesepisterna shallowly punctate with shiny interspaces; fascial foveae variable..... 94

94(93). Fascial foveae very broad and deep, dorsal edge extending at least two thirds of the way to the lateral ocelli; metasomal terga two and three shiny, impunctate; tegulae brownish hyaline; America east of Continental Divide *consors mesocopus*

Fascial foveae obscure, narrow, not extending above upper inner orbital margins; metasomal terga two and three finely folliculated and shiny; tegulae deep brown to black; montane species, Rocky Mountains ..... *paniscus paniscus*

95(3). Metasomal terga nearly or completely covered with short, appressed pubescence, most nearly complete on metasomal terga three to five ..... 96

Metasomal terga having discs nonpubescent, except for basal fasciae sometimes present on terga two and three ..... 98

96(95). Malar spaces long, at least as long as broad; posterior basitarsi four times as long as broad ..... 97

Malar spaces three-fourths as long as broad; posterior basitarsi broad, three and one-fourth times as long as broad (Pile of vertex, mesoscutum, scutellum and apical metasomal terga strongly tinged with ochreus) ..... *covilleae*

97(96). Pile of vertex and mesoscutum long and deep ochreus; mesepisterna dull above with punctures shallow and obscure; prothoracic spines absent; nervures deep brown to black; length 10-11 mm. ..... *clypeonitens*

Pile of vertex and mesoscutum short and pure white; mesepisterna shiny with deep punctures separated by shiny interspaces; prothoracic spines short and sharp; nervures light yellow-brown, especially basally; length 8-9 mm., *petalostemonis*

98(95). Mesepisterna with punctures shallow and sparsely scattered over shiny black surface, punctures two to four puncture widths apart on disc; malar spaces one-half as long as broad or less ..... 99

Mesepisterna with punctures deep and close, no more than one puncture width apart on disc; malar spaces three-fourths to seven-eighths as long as broad (shorter in *deserticola* Timb.) ..... 100

99(98). Antennae with under surface of flagellum light brownish yellow; mesepisterna with punctures almost obscure, at least four puncture widths apart on discs; metasomal terga five and six with disc having abundant golden erect pile; length 8 mm. ..... *prosopidis*

Antennae with under surface of flagellum reddish brown; mesepisterna with punctures distinct but at least two puncture widths apart on disc; metasomal terga five and six with disc having abundant, deep ferrugineous to black, erect pile; length 9-9.5 mm. ..... *algarobiae*

100(98). Metasomal terga six (and sometimes five) with disc having abundant, deep ferrugineous to black hairs; prothoracic spines at least as long as broad at base ..... 101

Metasomal terga five and six having disc covered with light hairs; prothoracic spines vestigial or absent . . . . . *salicicola*

101(100). Malar spaces about seven-eighths as long as broad; metasomal terga two and three with weak basal fasciae; apical fasciae loose and broad; length 8.5-9 mm. . . . . *daleae*

Malar spaces slightly less than three-fourths as long as broad; metasomal terga two and three with broad, dense basal fasciae; apical fasciae dense and broad; length 9.5-10 mm., *deserticola*

## DESCRIPTIONS OF THE SPECIES

### GROUP I—*productus*

### *Colletes productus* Robertson

(Fig. 1)

*Colletes productus* Robertson, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 62; 1904, Canadian Ent., vol. 36, p. 278; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 38; Leonard, 1926, Cornell Agric. Exper. Sta. Mem. no. 101, p. 1021; Robertson, 1928, Flowers and Insects, p. 10; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301 (questionable); Brimley, 1938, Insects North Carolina, p. 451.

Although this species resembles the *americanus* group, a multitude of characters clearly indicate that it does not belong there, and both sexes are easily distinguished from that group by their exceptionally long malar spaces, which are at least one and one-half times as long as wide in the males and as long as wide in the females. The great morphological differences in other characters indicate that the rimmed metapleural protuberances, which are common to the *americanus* group, may have been independently developed in *productus*.

*Male:* length 9-11 mm., wing length 6 mm.

Pile of body very sparse, ochreus to pale grey; pile of face clumped principally about antennal bases and extending below to basal portion of clypeus; malar spaces and lower half of clypeus relatively free of hair and shiny; hair of vertex pale grey and sparse; lower genal areas with hairs sparse, long, and plumose; mesoscutum with pile sparse, ochreus to tawny yellow; scutellum with weak lateral and posterior fringe of pale grey pile; mesoscutum with ochreus pile extending down to posterior lobe of pronotum having a few darker hairs among pale hairs on upper mesopleura; hair of mesepisterna very sparse, long, and branched, never sufficiently dense to conceal surface; upper lateral edges of propodeum with a dense clump of pale grey hairs, lateral and posterior faces of propodeum free of pile; legs with short, pale grey pubescence even on posterior femora; first metasomal tergum with few sparse hairs

not concealing surface to any extent, but with weak lateral fringes of greyish pile; metasomal tergal fasciae narrow and weak, easily removed by rubbing; fasciae present on first to fifth metasomal terga; discs of metasomal terga three to six with abundant, short, erect, ferrugineous to blackish pile; sternal fasciae composed of a few, sparse, apical, ochreus hairs.

Antennae long, flagellar segments about one and one-half times as long as wide; malar spaces at least one and one-half times as long as wide; clypeus long, densely punctate basally, punctures becoming sparser towards apex, lateroapical half shiny with very few punctures, clypeus flattened slightly medially with a weak furrow evident at base; elongate malar spaces and clypeus forming a snout-like extension to head; vertex shiny with few punctures. Prothoracic spines very short and sharp; anterior and posterior edges of pronotum raised with shallowly concave disc, most evident at lateral edge; mesoscutum black and shiny with very sparse, shallow punctures, punctures approximately three puncture widths apart even at anterior extremity of mesoscutum, mesoscutum with small impunctate area; scutellum with punctures coarse and dense on posterior half; mesepisterna shiny with obscure, shallow punctures on lower half, punctures becoming more distinct and much denser towards upper anterior face; metapleural prominences distinct but not reaching posterior margins of metapleura, rims dark brown, most conspicuous on anterior half; propodeum with lateral faces shiny, traversed by sharp rugae, lateroposterior edge abrupt, not rounded, with a weak ridge separating the two surfaces, basal area of propodeum with shallow, quadrate pits; tegulae dark brown hyaline; wings dusky hyaline with scattered, fine, ochreus pubescence most noticeable apically, nervures dark brown; legs black at bases, more brownish apically; hind basitarsi three times as long as wide. Disc of first metasomal tergum virtually impunctate, shiny; discs of terga two to four, shiny, and weakly folliculated.

*Female:* length 10-11 mm., wing length 6-7 mm.

Body black with a weak covering of hair on head and thorax, abdomen sparsely pubescent; hair of face sparse, concentrated chiefly about antennal bases, vertex with a very few, pale grey hairs; pile of upper genal areas dense white to pale grey, becoming sparser and longer towards ventral faces; hair of mesoscutum ochreus and very sparse, not concealing surface; scutellum with a dense rim of pale ochreus pile on lateral and posterior edges; posterior lobes of pronotum with a dense mat of whitish to grey hair;

mesepisterna with sparse, elongate, branched pubescence, not concealing surface; upper lateral surfaces of propodeum with dense clumps of ochreus hair; first metasomal tergum with but a few, long, pale grey hairs on anterior face, very weak lateral fringes of hair on first tergum, which do not reach to fascia, fascia white and sharply narrowed medially; metasomal terga two to five with fasciae not narrowed as on first tergum, a slight widening of fasciae laterally followed by an abrupt narrowing at extreme lateral margins; pile of legs short, moderately dense except on posterior femora, where pile is long, curled, and pale grey; sternal fasciae absent; discs of metasomal terga three to six with short, dark ferrugineous to black pubescence giving surface an ironish tinge.

Antennae short and dark, basal flagellar segment about as long as second; malar spaces at least as long as wide; clypeus shiny and sparsely punctate with large punctures over basal three-fourths, becoming shiny impunctate on apicolateral portions, a weak longitudinal median furrow most pronounced half way between base and apex; vertex shiny impunctate; fascial foveae deep, shiny impunctate. Prothoracic spines short and blunt; pronotum expanded slightly laterally as a convex structure; mesoscutum with shallow, sparse punctures over surface, punctures at least three puncture widths apart, even on extreme anterior surface of mesoscutum, impunctate area large and shiny; scutellum with deep, dense punctures over posterior half; mesepisterna with punctures shallow and obscure below, becoming deeper and denser towards the upper anterior portions, punctures on upper mesepisterna not more than one puncture width apart whereas those on posterior edges shallow and obscure; metapleural prominences strongly protuberant with dark brown rims, only slightly concave beneath; lateral faces of propodeum dull with a few, weak rugae near lateroposterior margins, basal area with distinct, quadrate pits; tegulae dark brown; wings dusky hyaline with weak, ochreus pubescence on surface; legs dark brown to black at bases, tibiae and tarsi much more reddish brown; posterior basitarsi wide and shallowly concave on upper surfaces, about two and three-quarters times as long as wide. First metasomal tergum weakly and sparsely punctate, punctures on lateral portion of disc about two puncture widths apart, becoming shallower and sparser on anterior and mid portions of disc; second and third metasomal terga with very weak, dense, follicle-like punctures giving them a roughened yet shiny appearance.

*Distribution:* Georgia: Margaret; Helen; Sarah. Alabama: Mobile; Kushla. North Carolina: Bryson City; Grandfather Mountain;

Aberdeen; Old Fort Road; Raleigh; Roaring Gap. Kentucky: southeast Kentucky. Virginia: Falls Church. New Jersey: Lakehurst. Massachusetts: Holliston; Needham.

*Flight records:* May 10 to July 26.

*Plant records: Rhus glabra; Xolisma ligustrina.*

The holotype, apparently from Carlinville, Illinois, is in the collection of the Illinois Natural History Survey.

Through the courtesy of L. K. Gloyd of the Illinois Natural History Survey, I have received the following information on the type of this species:

"In the Trans. Am. Ent. Soc. for 1891, vol. 18, on p. 49, Mr. Robertson wrote 'I submit a synopsis of all the species which occur in my neighborhood (Carlinville, Ill.) with notes on their time of flight and the flowers which they visit, as well as descriptions of new species'. So neither of the specimens from New Hampshire and Massachusetts at the University of Nebraska can be the holotype. Apparently Robertson placed the sign ♂ or ♀ immediately following the species name at the beginning of his descriptions to indicate upon which sex the description was based. In the case of *productus*, a '♀' follows the name but the last paragraph reads, 'One male, taken July 21st on flowers of *Apocynum cannabinum*.' In the paper by Martin H. Muma, Bull. Univ. Nebr. State Mus., vol. 3, No. 8, 1952, the type of *Colletes productus* is listed as a ♀. So I think the ♂ specimen here must surely be the holotype."

*Colletes arizonensis* sp. nov.

(Fig. 2)

This new species from the mountains of Arizona resembles *perileucus* rather closely. The males have dark pile on the vertex, mesoscutum, and scutellum, and have the first metasomal tergum closely punctate. The females are rather distinctive in having lateroapical elevated ridges on the apical ventral metasomal segment and abundant black pile on the thorax and head. An unusual character of both sexes is that the apical margin of the first metasomal tergum is bluntly rounded rather than with a broadly flattened fascial depression as on each of the remaining metasomal terga. The fascia of the basal tergum is composed of short, white pile at the extreme apex.

*Male:* length 8.25 mm., wing length 7 mm.

Pile of face long and white, sparse over clypeus, partially concealing surface, a few dark hairs below antennal bases; vertex with

pile predominantly black, with a few pale gray to ochreus hairs intermixed; upper genal areas with pile short, pale grey, a few darker hairs intermixed on anterior face, pile becoming much longer, denser, and whiter below; mesoscutum with a sparse covering of pale grey and black pile, becoming more predominant on median discal area; scutellum with a very narrow peripheral fringe of fine, pale grey pile, abundant, long, black pile over mediolateral areas; mesepisterna with pile long, white to pale grey, and fine; propodeum with tufts of long pile at upper lateroposterior margins, pile with a strong admixture of black hairs, lateral and posterior faces with long, fine, pale grey, erect pile; first metasomal tergum with an apical fringe of short, white pubescence, not lying in a depressed fascia, lateral fringes of white pile short, reaching apical fascia, disc with abundant, short, erect, whitish pile, not at all concealing surface; metasomal terga two to five with fasciae narrow, weak, and white; metasomal terga four to six with abundant, erect, short, black pile on discs; metasomal sterna two to five with weak apical fringes of white to pale grey pile.

Antennae deep reddish brown to black, flagellar segments one and one-half times as long as broad; malar spaces one-half as long as broad; clypeus weakly convex with a shallow, longitudinal median sulcus, surface weakly, striately punctate, punctures most dense along clypeofrontal regions and down median sulcus, punctures of lateral faces striate and separated by shiny interspaces; vertex shiny, impunctate. Prothoracic spines short and sharp, about as long as width across base; mesoscutum coarsely punctate over anterior one-half and lateral margins, impunctate area large; scutellum with a few coarse punctures about lateral and posterior margins, median discal area very sparsely punctate with broad, shiny interspaces, anterior one-half virtually impunctate; mesepisterna deeply punctate with shiny interspaces, punctures one-half puncture width apart; propodeum with basal area very shallowly, quadrately pitted, lateral and posterior faces shiny and rather sharply punctate; tegulae black; wings dusky with abundant, very short, fine, deep fulvous pubescence, nervures deep brown; legs deep brown to black; posterior basitarsi four times as long as broad. First metasomal tergum densely punctate on lateral and apical margins, punctures fine and no more than one puncture width apart, punctures becoming very sparse and much finer on median and medioapical faces where they are four to five puncture widths apart, apical margin not depressed to retain fascia, rather abruptly rounded with a very weak

preapical groove; second metasomal tergum densely, coarsely folliculated, follicles about one follicle width apart; metasomal sterna shiny; seventh ventral plates much as in *productus*, however with laterobasal projection blunt and weakly rounded (fig. 2).

*Female:* length 10 mm., wing length 7.75 mm.

Pile of face rather sparse, concentrated chiefly about antennal bases and along lower inner orbital margins, a few darker hairs intermixed below antennal bases; vertex with pile predominantly black, a few pale grey to dusky hairs intermixed; upper genal areas with pile short and pale grey, with a few longer, black hairs intermixed, pile becoming longer, whiter, and finer below; mesoscutum with a sparse covering of pale grey and black pile, black pile predominating on median discal area; scutellum with a narrow lateral and posterior fringe of white pile, having abundant, erect, black pile medially; mesepisterna with an admixture of pale grey and black pile on preepisterna and on upper mesepisterna, pile becoming longer and pure white below; propodeum with long tufts of intermixed black and pale grey pile on dorsal surface of lateroposterior margin, lateral and posterior faces with abundant, erect, pale grey pile; femora and tibiae of middle and hind pairs of legs with pile long and tinged with fulvous; abundant, short, black pile intermixed particularly on upper surfaces of tibiae; first metasomal tergum with a dense apical fringe of short, white pubescence, lateral fringes very weak and white, barely reaching fascia, disc with abundant, erect, whitish pile; metasomal terga two to four with fasciae narrow, white, and weak; metasomal terga three to five with abundant, erect, deep fulvous to black pubescence; metasomal sterna with sparse, erect, pale grey pile, particularly on apical one-third of each sternum.

Antennae brown below, black above, long, flagellar segments about as long as wide; malar spaces three-eighths as long as wide; clypeus flattened with a deep longitudinal median sulcus, clypeus sparsely, coarsely, striately punctate, punctures one to three puncture widths apart, with broad, shiny interspaces; vertex shiny, impunctate; fascial foveae very deep, broadened slightly medially, extending above inner orbital margins, reaching almost half way from inner orbital margins to lateral ocelli. Prothoracic spines short and sharp, about as long as width across the base; mesoscutum coarsely and densely punctate about anterior one half and lateral margins, impunctate area small; scutellum finely, almost contiguously punctate, about extreme lateral and posterior faces, punctures becoming sparse

in median discal area and absent on anterior one-third; mesepisterna densely and coarsely punctate, punctures no more than one-half puncture width apart with shiny, linear interspaces; propodeum with basal area very shallowly, quadrately pitted, lateral and posterior faces with numerous, sharp punctures, surface moderately shiny; tegulae deep brown to black; wings dusky, very densely covered with deep fulvous pubescence, nervures deep brown; legs deep brown to black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum very finely punctate about lateral and apical margins, punctures becoming exceedingly fine and sparse on median and medioapical surfaces where they appear to be folliculated rather than punctured; second metasomal tergum densely and finely folliculated; metasomal sterna dull, densely folliculated, last metasomal sternum with weak, elevated, lateral ridges, extending about apicolateral margins to posterior margin cutting off a narrow, shiny apical rim.

*Distribution:* Holotype, male, south slope Tumacacori Mountain, 8 miles west of Nogales, Arizona, 6000 feet, in the chaparral zone, July 20, 1949 (F. Werner and W. Nutting); allotype, female, top of Huachuca Mountains, Arizona, August 10, 1940 (E. S. Ross); paratypes: 2 males, south slope of Tumacacori Mountain, 8 miles west of Nogales, Arizona, 6000 feet, chaparral zone, July 20, 1949 (F. Werner and W. Nutting); 1 female, top of Huachuca Mountains, Arizona, August 10, 1940 (E. S. Ross).

The holotype is in the collection of the Musuem of Comparative Zoology at Harvard University and the allotype is in the collection of the California Academy of Sciences.

### *Colletes perileucus* Cockerell

(Fig. 5)

*Colletes perileucus* Cockerell, 1924, Proc. California Acad. Sci., ser. 4, vol. 12, p. 535; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 202.

The species, originally described from a female from Guaymas, Sonora, Mexico, has been recorded from California by Timberlake. The present work extends the range to Arizona and southwestern Texas. It is difficult to separate the females of *perileucus* and *albocinctus;* however, *perileucus* has the prothoracic spines very long and sharp, and the second metasomal tergum not depressed basally. There is some doubt as to the correct association of the sexes of *albocinctus* and it is not at all impossible that the female designated as *albocinctus* may prove to be a subspecies of *perileucus.* The males of the two species are markedly different, *perileucus* having

the malar spaces one-half as long as wide and the first metasomal tergum shiny and impunctate, whereas in *albocinctus* the malar spaces are slightly longer than wide and the first metasomal tergum is densely, coarsely punctate. The males of *perileucus* are distinguished from *arizonensis* by having the black pile only on the scutellum and in having the first tergum shiny and impunctate. The females are readily distinguished from closely related species by having black pile restricted to the vertex, mesoscutum, and scutellum, and also by the impunctate condition of the first metasomal tergum.

*Male:* length 10 mm., wing length 7.5 mm.

Pile of face long, dense, and pure white, completely concealing clypeus and lower face; vertex with pile long and pale grey; upper genal areas with pile long, dense, and pale grey, becoming much whiter and finer below; mesoscutum with pile long, dense, and dusky; scutellum with a dense covering of long pile, particularly about lateral and posterior margins, pile dusky on extreme peripheral edge, strongly admixed with black medially; mesepisterna with pile long, fine, and white; propodeum with dense fringes of white pile on lateroposterior margins from dorsal face to pedicel, lateral and posterior faces with abundant, very long, white pile; pile of legs sparse, short, and white; first metasomal tergum with a dense, broad, white apical fascia, lateral fringes of long, white pile extending to apical fascia, disc with abundant, long, erect, white to pale grey pile, partially obscuring the surface medially; metasomal terga two to five with fasciae narrow but pure white; metasomal terga four to six with abundant, erect, deep fulvous to black pubescence, not at all concealing surface; metasomal sterna two to five with dense apical fringes of white pile.

Antennae long and brown, flagellar segments one and one-half times as long as broad; malar spaces five-eighths as long as broad; clypeus weakly convex, rather densely and finely punctate, particularly on clypeofrontal margins and down median longitudinal line, punctures coarser on apicolateral faces and tending to be somewhat striate; vertex dull, densely and deeply punctate. Prothoracic spines long and sharp, at least one and one-half times as long as width across base; mesoscutum densely punctate over anterior and lateral margins, punctures becoming sparse medially, impunctate area large; scutellum coarsely punctate over posterior one half, punctures becoming finer anteriorly to absent on extreme anterior face, punctures not at all striate; mesepisterna with punctures shal-

low, coarse, one-half puncture width apart above to one puncture width apart below, interspaces shiny; propodeum with basal area not at all pitted, weakly roughened, lateral and posterior faces dull and weakly roughened; tegulae brownish hyaline; wings very weakly dusky with very sparse, deep fulvous pubescence apically, nervures brown; legs deep brown to black; posterior basitarsi four times as long as broad. First metasomal tergum shiny, sparsely folliculated, surface with a very deep bluish-black metallic lustre; metasomal sterna sparsely and finely folliculated; seventh ventral plates broad and elongate with median and lateral edges reflexed, much as in *productus* (fig. 5).

*Female:* length 11.5 mm., wing length 8 mm.

Pile of face short, white, and dense, particularly between antennal bases and compound eyes; vertex with abundant, back pile, with a few intermixed pale grey hairs; upper genal areas with pile predominantly short, pale grey, with a few intermixed, longer, black hairs, pile becoming much longer, finer, and whiter below, a wide band of appressed, white pubescence immediately posterior to each compound eye; mesoscutum with anterior and lateral margins having pile short, dense, and white, discal area with abundant, black hair intermixed; scutellum with a narrow fringe of pale grey pile about peripheral margins, median discal area predominantly covered with black pile; mesepisterna with pile long, fine, and white; propodeum with dense fringes of long, white pile on lateroposterior margins, extending down lateroposterior margins toward pedicle, lateral and posterior faces with sparse covering of long, erect, white pile; pile of anterior two pairs of legs short and white, posterior legs with pile long, plumose, and tinged with light ochreus; first metasomal tergum with apical fascia broad and pure white, weakly interrupted medially, lateral fringes of long, white pile just barely reaching apical fascia, disc with abundant, long, erect, whitish pile; metasomal terga two to four with fasciae broad, rather dense, and white; metasomal tergum five with a very narrow apical white fascia; second metasomal tergum with a broad basal fascia, remnants of a white basal fascia just evident on third metasomal tergum; metasomal terga four and five with abundant, erect, black pile on discal areas; metasomal sterna with weak apical fringes of short, white pile, usually interrupted medially, discs of metasomal sterna with a few, erect, pale grey hairs, not at all scopa-like.

Antennae brown, flagellar segments about as long as broad; malar

spaces one-third as long as broad; clypeus very weakly convex with a longitudinal median sulcus, surface coarsely but rather sparsely punctate with punctures one to two puncture widths apart, most densely punctate along median sulcus, interspaces shiny; vertex moderately shiny with numerous, very shallow, fine punctures; fascial foveae deep, slightly broadened medially, extending dorsally above inner margins of compound eyes, dorsal margins extending but one third of the way to lateral ocelli. Prothoracic spines very long and sharp, approximately three times as long as width across the base; mesoscutum densely punctate, punctures one-half to one puncture width apart over anterior one half and lateral margins, impunctate area large; scutellum rather coarsely punctate over posterior one half, punctures sparser and finer, becoming absent, on anterior face, punctures not at all striate; mesepisterna closely, coarsely, and deeply punctate, punctures no more than one-half puncture width apart with shiny interspaces; propodeum with basal area very finely rugate, not at all quadrately pitted, dull, lateral faces shiny and finely marked, posterior face dull and weakly roughened; tegulae brownish hyaline; wings dusky with a moderate covering of deep fulvous pubescence, especially apically, nervures dark brown; legs deep reddish brown; posterior basitarsi four times as long as broad. First metasomal tergum shiny, impunctate except for a few, very shallow, sparse follicles, surface tinged with a deep bluish-black lustre; second metasomal tergum shiny, rather densely and very finely folliculated; metasomal sterna shiny, coarsely and very sparsely folliculated, follicles one to four follicle widths apart.

*Distribution:* 1 female, Guaymas, Mexico, April 7, 1921 (E. P. Van Duzee) (cotype); 3 males, El Mayor, Baja California, April 1939 (C. D. Michener); 1 female, Wild Rose Canyon, Panamint Mountains, Inyo County, California, 7500 ft., May 28, 1937 (C. D. Michener), on *Prosopis juliflora glandulosa;* 1 female, Tombstone to Bisbee, Arizona, over 4500 ft., June 16, 1942 (H. A. Scullen); 1 male, 2 females, Big Bend Park, Hot Springs, Texas, April 11, 1949 (Michener-Beamer), on *Prosopis juliflora.*

The species has been taken on flowers of mesquite, *Prosopis juliflora,* and Timberlake also records a single specimen taken at the flowers of *Melilotus.* As far as present records indicate, *perileucus* appears to be a spring and early summer species.

The holotype from Sonora, Mexico, is in the California Academy of Sciences.

## *Colletes cercidii* Timberlake

(Fig. 3)

*Colletes cercidii* Timberlake, 1951, Wasmann J. Biol., vol. 9, pp. 198-200.

This and the following species, *C. rudis* Timberlake, deviate slightly from the typical members of the *productus* group and are placed here with some hesitancy. The seventh ventral plates and the genital capsules resemble those of the *productus* group except for certain specific characters. Both sexes of *cercidii* bear some resemblance to *skinneri* Viereck and *gilensis* Cockerell, but do not have the coarse puncturation of either species. The males have the malar spaces one-half as long as wide; dark pile intermixed on the vertex, mesoscutum, and scutellum; and the first metasomal tergum finely punctate. The females are similar to *skinneri,* but have the malar spaces shorter, the first metasomal tergum more finely punctate, the second metasomal tergum weakly depressed basally, and the second and third terga with faint basal fasciae.

*Male:* length 10 mm., wing length 7.75 mm.

Pile of face very long, dense, and white, completely concealing clypeus and antennal basal region; vertex with pile long and sparse, strongly intermixed with black; genal areas with upper surface having sparse, short, pale grey pile with a few dark hairs intermixed on anterior margins, pile becoming much longer, finer, and whiter below; mesoscutum with pile predominantly pale grey to white, particularly about lateral and anterior faces, abundant, black pile intermixed over discal area, being most dense on median portions of disc; scutellum with a narrow fringe of pale grey pile about lateral and posterior faces, discs with pile predominantly long and black; mesepisterna with pile long, fine, and white; propodeum with long fringes of white pile on dorsal lateroposterior margins, lateral and posterior faces with abundant, long, erect, pale grey pile; legs with pile short, sparse, and white; first metasomal tergum with apical fascia broad, dense, and white, lateral fringes of long, white pile extending to apical fascia, disc with abundant, erect, whitish pile; metasomal terga two to five with fasciae broad, dense, and white; metasomal terga four to six with discs having abundant, short, black, erect pile; metasomal sterna two to five having apical fringes of long, pale grey pile, pile much shorter medially.

Antennae long, reddish brown to brown, flagellar segments one and one-half times as long as broad; malar spaces one-half as long as broad; clypeus flattened medially with a very shallow, longitudinal median line, surface finely and densely punctate over basal one-

half, punctures becoming much more striate apically, striate punctures extending virtually to apex; vertex shiny, sparsely punctate, punctures one to three puncture widths apart. Prothoracic spines absent; mesoscutum densely and coarsely punctate over anterior and lateral margins, punctures one-half puncture width apart, impunctate area small; scutellum rather densely and coarsely punctate over posterior three-quarters, anterior face shiny, impunctate; mesepisterna with punctures coarse and dense, having shiny interspaces, punctures one-half puncture width apart; propodeum with the basal area not at all pitted, having a few, very weak, irregular rugae, lateral and posterior faces dull and roughened; tegulae deep brown; wings dusky with abundant, deep fulvous pubescence, nervures brown; legs deep brown to black; posterior basitarsi four and one-fourth times as long as broad. First metasomal tergum finely and rather densely punctate, punctures coarser laterally, becoming much finer on median surface, punctures one to two puncture widths apart; metasomal terga two and three coarsely and rather densely folliculated, interspaces shiny; second metasomal tergum very weakly depressed basally; metasomal sterna shiny, coarsely and sparsely folliculated; seventh ventral plates broadly subtriangular, with apical margins extended and rounded, median margins strongly reflexed, with basal hair bands extending across base and down median reflexed margins (fig. 3).

*Female:* length 11.5 mm., wing length 8.5 mm.

Pile of face short and dense, particularly about antennal bases and along lower inner orbital margins; mesoscutum with pile pale grey about anterior and lateral faces with abundant, deep black pubescence on median discal area; scutellum with a very narrow fringe of pale grey pile about lateral and posterior faces, disc with abundant, erect, black pile; mesepisterna with pile long, fine, and pale grey; propodeum with dense fringes of long, pale grey pile on upper lateroposterior margins, extending down toward pedicel, lateral and posterior faces with abundant, erect, pale grey pile; anterior two pairs of legs with pile long and white, posterior pair of legs with abundant, long, plumose pile on femora and tibiae, strongly tinged with ochreus; first metasomal tergum with a very weak, white fascia, broadly interrupted medially, tergum with dense lateral fringes of white pile extending to fascia, disc with abundant, erect, pale grey pile; metasomal terga two to four with the fasciae weak, broad, and white, occasionally interrupted or partially interrupted medially; metasomal terga four and five with abundant, short,

deep fuscous to black, erect pile on discal areas; metasomal sterna two to four with very weak fringes of pale grey pile, discal area with abundant, erect, light ochreus pile, forming a weak scopa on metasomal sterna two and three.

Antennae long and reddish brown, flagellar segments one and one-eighth times as long as broad; malar spaces one-third as long as broad; clypeus flattened medially, very densely, coarsely, striately punctate to apex, interspaces shiny, a very faint trace of a median longitudinal sulcus; vertex shiny, sparsely punctate, with punctures one to three puncture widths apart with shiny interspaces; fascial foveae narrow and deep, curved at dorsal extremity toward lateral ocelli, inner margin of curve reaching just barely over one third of way from inner orbital margins to lateral ocelli. Prothoracic spines very short, vestigial; mesoscutum very coarsely and densely punctate over anterior and lateral margins, impunctate area very small, with punctures much sparser over median discal area; scutellum densely, finely, contiguously punctate about extreme lateral and posterior margins, punctures becoming much coarser and sparser toward anterior face, where they vary from one-half to one puncture width apart, anterior one third shiny, impunctate; mesepisterna deeply and densely punctate, with shiny interspaces, punctures one-half puncture width apart; propodeum with basal area smooth, very shallowly pitted, pits not at all uniformly quadrate, lateral and posterior faces roughened, dull; tegulae deep brown to black; wings dusky with abundant, deep fulvous pubescence, nervures dark brown; legs dark brown to black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum finely and densely punctate, with shiny interspaces, punctures approximately one puncture width apart, punctures of apical and median faces much finer than lateral discal areas; second metasomal tergum very finely and densely folliculated, surface dull, second metasomal tergum with a weak basal depression; metasomal sterna shiny, coarsely and densely folliculated.

*Distribution:* Timberlake records the holotype male and the allotype female from Box Canyon, Riverside County, California, on March 31, 1934, on *Cercidium torreyanum,* and the following paratypes on the same flower: 2 males and 2 females, Box Canyon, March 31 and April 13, 1934; 1 female, Oasis, Riverside County, March 27, 1934; 1 female, Gila Bend, Arizona, March 28, 1934 (Timberlake); 1 female, Morristown, Arizona, May 21, 1945; 1 male, Potholes, Imperial County, California, April 10, 1923 (E. P. Van Duzee).

I have seen the male paratype from Box Canyon, April 13, 1934, the female paratype from Gila Bend, Arizona, and the male paratype from Potholes. The types are in the collection of the Citrus Experiment Station, Riverside, California.

### *Colletes rudis* Timberlake

(Fig. 4)

*Colletes rudis* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 197.

The species is described from two males taken at Indio, California. It is a rather unique species with roughly quadrate seventh ventral plates. There is a slight resemblance to *C. productus* but *rudis* has only a few black hairs on the posterior portion of the scutellum; the malar spaces are shorter, approximately three-fourths as long as wide; and the metapleural prominences are absent.

*Male:* length 10 mm., wing length 7 mm.

Pile of face long, dense, and white, completely concealing clypeus and antennal bases; vertex with pile rather dense and tinged with grey, a few darker hairs intermixed; genal areas with upper surfaces having abundant, short, pale grey pile, pile becoming much longer, finer, and whiter below; mesoscutum with pile long, dense, and predominantly pale grey, a few darker (not black) hairs intermixed on median discal area; scutellum with very dense lateral and posterior rims of pale grey pile, pile having a few black hairs intermixed; mesepisterna with pile long, fine, and white; propodeum with long, pale grey fringes of pile on upper lateroposterior margins, lateral and posterior faces with abundant, erect, pale grey pile; legs with pile short, sparse, and white; first metasomal tergum with apical fascia broad and white, lateral fringes of pale grey pile weak, barely reaching to apical fascia, disc with abundant, erect, pale grey pile; metasomal terga two to four with fasciae broad, weak, and pure white; fascia of fifth metasomal tergum very weak, evident only as an apical fringe of fine, white pile; metasomal terga three to six with abundant, very short, black, erect pubescence, not at all concealing surface; metasomal sterna two to five with long apical fringes of white pile, pile somewhat shortened medially.

Antennae long, deep brown to black, flagellar segments one and one-fourth times as long as broad; malar spaces three-fourths as long as broad; clypeus weakly convex, flattened medially, very finely and densely punctate over basal three-fourths, punctures becoming somewhat striate and much sparser on lateroapical margins; vertex dull, densely and deeply punctate. Prothoracic spines very short; mesoscutum very coarsely and densely punctate over anterior and

lateral faces, impunctate area very small with numerous coarse punctures lying irregularly on median area; scutellum finely, densely, contiguously punctate about lateral and posterior edges, punctures becoming coarser and sparser anteriorly, never more than one-half puncture width apart to anterior face; mesepisterna coarsely, densely, almost contiguously punctate, with shiny, linear interspaces, interspaces becoming dull below; propodeum with basal area shallowly, irregularly, quadrately pitted, lateral and posterior faces dull and roughened; tegulae deep brown to black; wings with abundant, deep fulvous pubescence, nervures brown; legs black; posterior basitarsi four times as long as broad. First metasomal tergum densely punctate with moderately fine punctures, punctures becoming much sparser and finer medially and on anterior portions, punctures approximately one-half to one puncture width apart laterally; second metasomal tergum very densely and finely punctate or coarsely folliculated, punctures one-half to one puncture width apart; metasomal sterna shiny, finely and sparsely folliculated; seventh ventral plates roughly quadrate with lateral and median margins weakly reflexed (fig. 4).

*Distribution:* One male, 5½ miles west of Indio, California, February 18, 1946 (P. H. Timberlake), at the flowers of *Encelia farinosa* (holotype).

I have only seen the holotype. However, Timberlake records a male paratype taken at the same time and place as the holotype. The types are in the collection of the Citrus Experiment Station, Riverside, California.

### *Colletes gilensis* Cockerell

(Fig. 6)

*Colletes gilensis* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 41; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 24; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1899, Entom., vol. 32, p. 155; 1901, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 125; 1901, Ent. News, vol. 12, p. 41; 1902, Amer. Nat., vol. 36, p. 810; 1904, Entom., vol. 37, p. 6; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 23; Cockerell, 1909, Psyche, vol. 12, p. 87; Gibson, 1914, Rept. Ent. Soc. Ontario, p. 124 (out of known range); Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 398.

The species occurs in the southwestern part of the United States and in northern Mexico, from Colorado south to New Mexico and Arizona and east to the Big Bend country of Texas. It can be distinguished by its very large size and the very coarse puncturation of the metasomal terga, but may be confused with *compactus* Cresson. The males, however, have short malar spaces, about one-half

as long as broad, and the female lacks the elevated ridges on the last metasomal sternum.

*Male:* length 14 mm., wing length 10 mm.

Face with pile coarse, dense, and pure white, completely concealing the clypeus, a few darker hairs along inner orbital margins; vertex with mixture of black and light pile; genal areas with upper surfaces having a few black hairs but predominantly white, pile becoming very long, white, and plumose on lower surfaces; mesoscutum with strong mixture of black pile; scutellum with abundant, long, black and pale grey pile on posterior and lateral faces; mesepisterna with long, fine, plumose pile, white below with a few black hairs on pre-episterna; propodeum with dorsolateral margins with dense clump of long, pure white pile, lateral and posterior faces with abundant, very fine, erect, white pile; legs with pile white, sparse, and long; metasomal terga one to five with broad, dense, white apical fasciae; metasomal tergum one with lateral fringes of pure white pile to apical fascia, disc and anterior face with abundant, fine, erect pile; metasomal tergum two with few, very fine hairs over basal portion; metasomal terga three to six with abundant, short, black, erect discal pile; metasomal tergum six lacking apical fascia; metasomal tergum seven with deep brown, appressed pile; metasomal sterna two to five with broad apical fasciae of pure white pubescence, broadest medially on terga two to four; metasomal sterna three to five with abundant, long discal pile tinged with ochreus.

Antennae long and brown, flagellar segments one and one-half times as long as broad; malar spaces one-half as long as broad; clypeus weakly convex with sharp median longitudinal sulcus, sulcus with close punctures, lateral clypeal areas coarsely and densely punctate over basal half, punctures sparse with broad shiny interspaces apically; vertex densely punctate with shiny interspaces. Prothoracic spines long and sharp, about one and one-half times the width across the base; mesoscutum densely and coarsely punctate, punctures contiguous to one-half puncture width apart over anterior and lateral margins, impunctate area small; scutellum with anterior one-fourth shiny and sparingly punctate, posterior three-fourths coarsely and densely punctate to posterior margin where punctures are contiguous; mesepisterna coarsely and densely punctate with shiny interspaces, tending to striately punctate above; propodeum having basal area broad with weak, quadrate pits, lateral and posterior faces dull, roughened, and weakly rugose; tegulae deep

brown; wings dusky with abundant, long, brownish pubescence over apical half, nervures brown; legs dark brown; posterior basitarsi four and one-half times as long as broad. Metasomal tergum one coarsely and densely punctate, punctures no more than one-half puncture width apart, a weak median longitudinal impunctate ridge transversing disc, extreme apical margin raised as a flange-like apex with a shallow preapical groove, most evident at medial area; metasomal terga two and three densely and coarsely punctate, punctures one-half to one puncture width apart; metasomal tergum two sharply depressed basally; metasomal terga three to six with punctures of variable coarseness with shiny interspaces; metasomal sterna shiny and sparsely folliculated or weakly punctate; seventh ventral plates transversely quadrate with laterobasal process long (fig. 6).

*Female:* length 14.5 mm., wing length 11 mm.

Face with pile sparse, white, and erect, a few hairs overhanging clypeus from frontoclypeal suture; vertex with mixture of long black and shorter pale grey pile; genal areas with upper surfaces having mixture of black and pale grey pile, becoming longer and much finer to pure white below; mesoscutum with mixture of black and pale grey pile extending to extreme anterior surface; scutellum with strong covering of long, black pile intermixed with shorter, finer, pale grey hairs particularly about extreme margins; mesepisterna with pile long, fine, and pure white, a few darker hairs on preepisterna; propodeum with dense lateroposterior clumps of long, white pile, lateral and posterior faces with few, scattered, long, fine, white hairs; anterior pair of legs with long, white femoral pile, tibiae and tarsi with pile tinged with ochreus, second and third pairs of legs with pile tinged with ochreus, a few, short, spinelike hairs on upper surface of posterior tibiae; metasomal terga one to five with dense, white apical fasciae, much narrowed on tergum five; metasomal tergum one with long lateral fringes of white pile, disc and anterior face with few, short, fine hairs; second metasomal tergum with weak basal fascia; metasomal terga three and four with few, short, white hairs forming rudiments of weak basal fascia; metasomal terga two to five with discal areas having short, black, erect pubescence; metasomal tergum six with pile golden to brown and appressed; metasomal sterna with apical margins having few, short, fine, white hairs, discal areas with abundant, fine, erect pile tinged with ochreus.

Antennae reddish brown, flagellar segments as long as broad; malar spaces three-eighths as long as broad; clypeus weakly convex

with median longitudinal sulcus not reaching apex or base, sulcus with few, coarse, contiguous punctures, lateral faces coarsely and striately punctate, closely punctate about base and sparsely punctate with broad shiny interspaces apically; vertex shiny, finely punctate; fascial foveae narrow and long, broadened sharply medially, dorsal portions pointed and curved, reaching two thirds of the way to lateral ocelli. Prothoracic spines long, about one and one-half times as long as width across base; mesoscutum densely and coarsely punctate, punctures no more than one-half puncture width apart about anterior and lateral margins, impunctate area small; scutellum with anterior one fourth shiny and sparingly punctate, posterior three fourths becoming more densely and finely punctate toward posterior margins; mesepisterna coarsely and densely punctate with punctures becoming much finer on posterior faces, almost rugosely punctate with shiny interspaces; propodeum with basal area broad, shallowly, quadrately pitted, lateral and posterior faces dull and weakly roughened; tegulae brown; wings dusky with abundant, long, brownish pubescence over apical one third, nervures brown; legs brown; posterior basitarsi three and one-third times as long as broad. Metasomal tergum one coarsely and densely punctate, punctures varying from one-half to one puncture width apart, apical margin reflexed slightly with a shallow preapical groove most evident medially, shallow longitudinal median impunctate ridge; metasomal tergum two with punctures deep and sparser than on tergum one, basal area sharply depressed, apical margin slightly reflexed; metasomal tergum three with punctures shallow, finer, and separated by one to three puncture widths; metasomal terga four and five shiny and finely punctate; metasomal sterna shiny, coarsely folliculated, apical margins hyaline, impunctate.

*Distribution:* Colorado: Pueblo; Grand Junction; Colorado Springs; Boulder; Greeley; Halls Valley. New Mexico: Las Vegas; White Mountains; Gila; Jemez Springs; Socorro County. Arizona: Oak Creek Canyon; Huachuca Mountains; Grand Canyon; Flagstaff. Texas: Davis Mountains; Chisos Mountains, Big Bend National Park.

*Flight Records:* This appears to be an aestival species, occurring from June 15 to August 21.

*Plant records: Melilotus alba, Petalostemum candidus, P. flavescens, P. oligophyllus, Potentilla thurberi, Solidago canadensis.*

The type of this species, a male from West Fork of the Gila River,

New Mexico, has not been located. It was last recorded in the Cockerell collection.

### *Colletes skinneri* Viereck

(Fig. 7)

*Colletes skinneri* Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 58; Cockerell, 1905, Psyche, vol. 12, p. 86; 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 425; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 21; Cresson, 1928, Mem. Amer. Ent. Soc., no. 5, p. 64.

This species is most likely to be confused with *C. gilensis* or *vandykei* Timberlake. However, both sexes can be readily distinguished by the malar spaces, which surpass both the aforementioned species in length. The malar spaces of the male are approximately one and three-eighths times as long as broad, and those of the female three-quarters as long as broad, much longer than its closest relative, *gilensis,* in which these spaces are almost linear.

*Male:* length 10 mm., wing length 7.5 mm.

Pile of face long, most dense about antennal bases, clypeus incompletely concealed with a long, overhanging fringe of pile from clypeofrontal regions, pile mostly pale grey with a few darker hairs intermixed below and mesad to antennal bases; vertex with a mixture of dark and pale grey pile, sparse; genal areas with a weak covering of short, pale grey to light ochreus pile above, pile becoming much longer, denser, and finer below; mesoscutum with a strong admixture of black pile, particularly on median discal area, pile about anterior and lateral faces predominantly pale grey to tinged with yellowish; scutellum with a narrow fringe of pale grey pile about lateral and posterior faces, pile of disc predominantly black; mesepisterna with a sparse covering of long, fine pile, pile tending to grey to tinged with ochreus above, becoming much whiter to pale grey below; propodeum with long fringes of dusky pile along upper lateroposterior margins, lateral and posterior faces with abundant, long erect, pale grey pile; legs with pile long, sparse, and pale grey; first metasomal tergum with apical fascia weak and white, broadly interrupted medially, lateral fringes of pale grey pile weak, barely extending to apical fascia, disc with abundant, erect, pale grey pile; metasomal terga two to five with fasciae weak and pure white, often interrupted medially; metasomal terga three to six with discs having abundant, very short, black pile intermixed with a few, longer, pale grey hairs, not at all concealing surface; metasomal sterna two to four with narrow apical fringes of white to pale grey pile.

Antennae deep reddish brown, flagellar segments one and one-third times as long as broad; malar spaces one and three-eighths times as long as broad; clypeus convex with a longitudinal median sulcus, rather densely and coarsely, striately punctate about latero-frontal regions and down longitudinal median sulcus, lateroapical regions sparsely punctate with broad, shiny interspaces; vertex deeply and coarsely punctate with shiny interspaces, punctures contiguous to one-half puncture width apart; compound eyes weakly petiolate as viewed from above. Prothoracic spines very short and sharp; mesoscutum densely and coarsely punctate over anterior one half and lateral margins, punctures no more than one-half puncture width apart, impunctate area small; scutellum densely and coarsely punctate over posterior two thirds, punctures contiguous except along median longitudinal line, anterior face sparsely punctate to virtually impunctate; mesepisterna densely, weakly striately punctate above, dull, punctures becoming less striate on lower faces and interspaces more shiny; propodeum with basal area being shallowly and quadrately pitted, lateral and posterior faces dull and roughened; tegulae brownish hyaline; wings dusky, very densely covered with a deep fulvous pubescence, nervures dark brown; legs reddish brown to black; posterior basitarsi four times as long as broad. First metasomal tergum very densely and coarsely, almost contiguously punctate over entire surface, punctures slightly sparser along median anterior face, surface rather dull; second metasomal tergum densely punctate, punctures one-half to one puncture width apart, being much finer and denser medially and basally; metasomal sterna shiny, sparsely and weakly folliculated; seventh ventral plates closely resembling those of *gilensis* but having median fringe much longer and denser (fig. 7).

*Female:* length 11 mm., wing length 8 mm.

Pile of face long, white to pale grey with a few darker hairs intermixed below antennal bases; clypeus with a weak covering of overhanging, pale grey pile; vertex with pile predominantly long and black amongst finer, pale grey hairs; genal areas with abundant, erect, pale grey pile, pile becoming much longer, finer, and whiter below, with a very weak rim of short, appressed, white pubescence immediately posterior to each compound eye; mesoscutum with abundant, black pile intermixed with pale grey, black pile becoming most predominant on median discal area; scutellum with a lateral and posterior fringe of long, pale grey pile, discal area covered with erect, black pile; mesepisterna with pile long, fine, pale grey to

white; propodeum with long fringes of white to pale grey pile on lateroposterior margins, extending down toward the pedicel, lateral and posterior faces with pile long, fine, and erect; pile of anterior two pairs of legs has long, white fringes from the femora, posterior legs with pile rather sparse, long, plumose, and tinged with ochreus, particularly on femora and tibiae; first metasomal tergum with apical fascia narrow and white, broadly interrupted medially, lateral fringes of pale grey pile weak and barely reaching apical fascia, disc with sparse, erect, whitish pile, pile short; metasomal terga two to five with fasciae white and broad, sharply narrowed medially; metasomal terga three to five with abundant, erect, black pile on discal areas, pile becoming much longer on apical terga; metasomal sterna with very weak fringes of short, pale grey pile on extreme apical margins.

Antennae brown, flagellar segments about as long as broad; malar spaces three-fourths as long as broad; clypeus weakly convex, flattened medially to having a very weak, longitudinal median groove, clypeus rather coarsely and densely striately punctate about clypeofrontal regions and along median depressed sulcus, lateroapical portions shiny and very sparsely punctate; vertex densely punctate with shiny interspaces; fascial foveae sharply delineated, narrow, curving inward from dorsal margins of compound eyes toward lateral ocelli, reaching almost one-half way to lateral ocelli from upper inner orbital margins. Prothoracic spines short and heavy; mesoscutum very densely and coarsely punctate over entire surface, punctures no more than one-half puncture width apart, impunctate area absent; scutellum with extreme posterior and lateral margins finely, contiguously punctate, dull, punctures much coarser over discal area with shiny, linear interspaces, scutellum punctate to anterior margin, a weak longitudinal median groove extending length of scutellum; mesepisterna densely, weakly striately punctate, punctures no more than one-half to one puncture width apart, surface dull; propodeum with basal area narrow and very shallowly pitted, lateral and posterior faces dull and roughened; tegulae deep brown; wings dusky with abundant, fulvous pubescence, nervures brown; legs brownish black; posterior basitarsi four times as long as broad. First metasomal tergum very densely and coarsely punctate, punctures one-half to one puncture width apart except on a median longitudinal impunctate line where punctures are very sparse to absent, interspaces shiny; second metasomal tergum very finely punctate or coarsely folliculated, interspaces shiny; metasomal sterna

coarsely and rather densely folliculated on apical half of each sternum, surface shiny.

*Distribution:* One female, Beulah, New Mexico (Skinner) (holotype); 1 male, Beulah, New Mexico, August 18 (T. D. A. Cockerell) (allotype); 1 female, Catalina Mountains, Arizona, August 21, 1942 (E. C. Van Dyke).

The holotype from New Mexico is in the Academy of Natural Sciences of Philadelphia.

### *Colletes vandykei* Timberlake

(Fig. 8)

*Colletes vandykei* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 200.

This species is based on a single male taken from the Santa Rita Mountains of Arizona. It is similar to *arizonensis,* differing in its exceptionally large size and in having abundant, black pile extending well down the mesepisterna. The apical margins of the first metasomal terga in both species are very similar in that the fasciae do not lie in abruptly depressed margins but rather fringe a broadly rounded apex, in both species there is evidence of a very narrow and weak preapical groove, particularly laterally. Genitalically the species is very similar to *arizonensis, skinneri,* and *gilensis.* The seventh ventral plates of *vandykei* are much more distinctly quadrate than either of the above-mentioned species and have the laterobasal projections much shorter and blunter.

*Male:* length 13 mm., wing length 9.25 mm.

Pile of face long about antennal bases and along lower inner orbital margins, with a strong admixture of black pile immediately below antennal bases; clypeus covered partially by an overhanging fringe of pale grey pile; vertex with a mixture of black and pale grey pile, particularly in ocellar triangle; upper genal areas with pile predominantly pale grey, however having a few darker hairs on anterior face, pile becoming much longer, finer, and pure white below; mesoscutum strongly covered with a mixture of black and pale grey pile, black predominating medially; scutellum with but a very narrow, lateral and posterior fringe of pale grey pile, discal area with abundant, long, black pile; mesepisterna with an admixture of pale grey, dark, and black pile on upper half, pile predominantly light to pale grey below; propodeum with very dense fringes of black and white pile on upper lateroposterior margins, dense fringes extending down toward pedicel and becoming whiter ventrally, lateral and posterior faces with abundant, erect, dusky pile; pile of legs short, sparse, and predominantly white, with a

weak admixture of black pile most evident on fringes of prefemora; first metasomal tergum with a narrow apical fascia of pure white pile, interrupted medially, lateral fringes of pale grey pile weak, barely reaching apical fascia, disc with abundant, very short, whitish pile; metasomal terga two to four with narrow, white apical fasciae, broadly interrupted medially; metasomal terga five and six with abundant, erect, black pile on the discal areas; metasomal sterna two to five with very weak apical fringes of pale grey pile.

Antennae deep brown to black, flagellar segments one and one-fourth times as long as broad; malar spaces one-half as long as broad; clypeus convex, weakly flattened medially, surface very coarsely, striately punctate about laterobasal edges and down a median longitudinal line to apex, lateroapical portions shiny, impunctate; vertex densely punctate, punctures contiguous to one puncture width apart, interspaces shiny. Prothoracic spines very short and sharp, about as long as width across base; mesoscutum very densely and coarsely punctate, punctures almost contiguous on anterior two-thirds and lateral margins, impunctate area absent; scutellum densely and coarsely punctate over entire surface, a deep longitudinal median groove running to anterior margin, mesepisterna with punctures coarse and dense, one-half to one puncture width apart with interspaces shiny; propodeum with basal area having a number of weak, longitudinal rugae, not at all forming quadrate pits, lateral and posterior faces dull and roughened; tegulae deep brown to black, rather finely and densely punctate; wings dusky with abundant, deep fulvous pubescence, nervures dark brown; legs black; posterior basitarsi four times as long as broad. First metasomal tergum densely covered with moderately coarse punctures, punctures much finer than those of mesoscutum and approximately one puncture width apart, interspaces shiny, apical margin very weakly reflexed, giving it a blunt, rounded appearance and also giving an impression of a very shallow, preapical groove, most evident laterally; metasomal terga two, three, and four very coarsely and sparsely folliculated, follicles varying from one to three follicle widths apart, interspaces shiny, black; metasomal sterna shiny, coarsely and sparsely folliculated; seventh ventral plates much more quadrate than either *skinneri* or *gilensis* and having laterobasal projections short and blunt (fig. 8).

*Distribution:* One male, Madera Canyon, Santa Rita Mountains, Arizona, August 15, 1940 (E. C. Van Dyke) (holotype).

The type is in the collection of the California Academy of Sciences.

## GROUP II—*compactus*

### *Colletes compactus compactus* Cresson

(Fig. 9)

*Colletes compacta* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 166; Patton, 1879, Proc. Boston Soc. Nat. Hist., vol. 20, p. 142; Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 115; Viereck, 1903, Ent. News, vol. 14, p. 120; Robertson, 1904, Canadian Ent., vol. 36, p. 275; Cockerell, 1905, Psyche, vol. 12, p. 86; Robertson, 1906, Science, vol. 23, p. 309; Lovell, 1907, Can. Ent., vol. 39, p. 363; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 25; Smith, 1910, Ann. Rept. New Jersey State Mus. for 1909, p. 694; Robertson, 1914, Ent. News, vol. 25, p. 70; Viereck, 1916, Conn. Geol. Nat. Hist. Bull., vol. 22, p. 740; Cresson, 1916, Mem. Amer. Ent. Soc., no. 1, p. 107; Rau and Rau, 1916, J. Animal Behaviour, vol. 6, p. 367; Rau, 1922, Trans. Acad. Sci. St. Louis, vol. 24, p. 37; Criddle *et al.*, 1924, Rept. Ent. Soc. Ontario, p. 99; Robertson, 1926, Psyche, vol. 33, p. 116; 1926, Ecology, vol. 7, p. 378; Leonard, 1926, Cornell Agric. Exper. Sta. Mem., no. 101, p. 1021; Robertson, 1928, Flowers and Insects, p. 10; Pearson, 1933, Ecolog. Monogr., vol. 3, p. 384; Brimley, 1938, Insects of North Carolina, p. 451; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 400.

This is one of the more robust forms of the genus and is distributed throughout North America south of the Boreal zone. The male is readily distinguished by the long malar spaces and deep median longitudinal sulcus of the clypeus, and the female has strong elevated lateral ridges on the last metasomal sternum. There is a progressive decrease in the ratio of black to white pile from the type locality in the east to the western part of the Great Plains, but through this range the black pile of the thoracic dorsum is evident.

*Male:* length 11 mm., wing length 8 mm.

Face with pile long and dense about antennal bases, much shorter and appressed along lower inner orbital margins, abundant, long, white pile overhanging clypeus from frontoclypeal suture and concealing upper and lateral surfaces; inner orbital margins with mixture of long, black hairs below antennal bases; vertex with mixture of black and light ochreus hairs; genal areas with upper surfaces with mixture of black and dusky pile, becoming longer, denser, and pure white on lower surfaces; mesoscutum with mixture of long, weakly plumose, dusky and black pile, black pile predominating over posterior portions of disc; scutellum with pile very long, plumose, and mostly black; mesepisterna with pile pale grey, weak admixture of black hairs above and on pre-episterna; propodeum with strong lateroposterior fringes of pale grey pile, lateral and posterior faces with abundant, long, erect, pale grey pile, not concealing surface; legs with pile sparse, fine, and white; metasomal terga one to five with broad apical fasciae weakly covered with pure white, short pubescence; metasomal tergum one with fascia narrow, almost

absent medially, lateral fringes of long, white pile, discal area and anterior face with abundant, fine, erect pile; metasomal terga four to six with scattered, long, erect, ferrugineous hairs; metasomal tergum seven with pile brown, appressed; metasomal sterna two to five with broad apical fasciae of pure white pile.

Antennae long and brown, flagellar segments one and three-fourths times as long as broad; malar spaces as long as broad; clypeus long with a deep longitudinal median sulcus bordered by two, lateral, shiny, sparsely punctate rims, a few shallow punctures along medial sulcus; vertex dull, sparsely and weakly punctured with narrow, shiny interspaces. Prothoracic spines short and sharp, about as long as the width across the base; mesoscutum densely and coarsely punctate with punctures one-half to one puncture width apart on anterior and lateral faces; scutellum with anterior one-half impunctate except for a few, shallow, puncturelike depressions, surface shiny, posterior one-third closely and densely punctate with punctures contiguous on posterior margin; mesepisterna coarsely and closely punctate, punctures about one puncture width apart with shiny interspaces; propodeum with basal area broad, not pitted but with irregular striae, lateral and posterior faces finely roughened, not striate or rugose; tegulae light brown; wings whitish hyaline with scattered, fine, light pubescence apically, nervures brown; legs reddish brown; posterior basitarsi five and one-half times as long as broad. Metasomal tergum one densely and coarsely punctate over entire surface, punctures almost contiguous with linear, shiny interspaces; metasomal tergum two with punctures deep and coarse as first tergum but separated by one to two puncture widths, basal area sharply depressed, apical fascia in smooth hyaline depression most evident laterally; metasomal terga three to six shiny, weakly punctate or folliculated; metasomal sterna shiny, finely and densely folliculated apically; seventh ventral plates roughly quadrate, with median, lateral, and basal margins reflexed, discs densely covered with pile (fig. 9).

*Female:* length 13 mm., wing length 9 mm.

Face with strong mixture of black and pale grey pile about antennal bases and lower frontal regions; clypeus bare; except for a few overhanging hairs from frontoclypeal margin; vertex with pile long, predominantly black with finer, intermixed, pale grey hairs; genal areas with upper surfaces having black pile predominating, pile becoming longer, denser, and pure white on lower surfaces; mesoscutum with dense covering of black and white pile; scutellum

with pile long and black about anterior and lateral margins; mesepisterna with pile long, white, and plumose, a few dark hairs on extreme upper surfaces; propodeum with lateroposterior margins with strong fringe of pale grey to light ochreus pile, occasionally with a few, scattered, dark hairs, lateral and posterior faces with few, fine, light hairs; legs with pile white, except on posterior femora and tibiae where it is tinged with ochreus and having some short, spinelike, dark hairs on upper faces; metasomal tergum one with weak apical fascia only evident laterally; metasomal terga two to four with fasciae broad, pure white, and weak; metasomal terga three to five with a few, erect, long, brown hairs on discs; metasomal tergum six with pile deep brown to black and appressed; metasomal sterna with a few, light ochreus hairs along apical margins.

Antennae brown, flagellar segments as long as broad; malar spaces three-eighths as long as broad; clypeus with median portion flattened to weakly concave, surface roughened and dull with scattered, coarse, shallow punctures separated by one to two puncture widths; vertex finely and densely punctate with shiny interspaces. Prothoracic spines absent; mesoscutum coarsely and densely punctate over anterior half and lateral margins, punctures almost contiguous, median impunctate discal area large; scutellum with anterior two thirds shiny, impunctate, posterior one third with punctures obscure and dense; mesepisterna coarsely and densely punctate with shiny interspaces; propodeum with basal area broad, not pitted but with numerous longitudinal striae, lateral and posterior faces dull and weakly roughened; legs deep reddish brown; posterior basitarsi three and three-fourths times as long as broad; metasomal tergum one with disc finely and densely punctate, punctures varying from one-half to one puncture width apart; metasomal tergum two with disc very finely punctate, punctures approximately one puncture width apart and slightly smaller than those on tergum one, apical fascia in sharply declivous hyaline depression; metasomal terga three to five with discs shiny, weakly punctate or folliculated; metasomal sterna two to four coarsely and sparsely folliculated, one to three follicle widths apart, apical margins light hyaline; last metasomal sternum with two, strongly elevated, lateral ridges extending from base to apex, converging slightly and most pronounced apically.

*Distribution:* The subspecies is found throughout America south of the Boreal zone and east of the Great Divide, occurring in greatest abundance in the eastern, particularly seaboard, portions of the

United States and Canada. On the basis of present collections, *c. compactus* is not known to occur in the deep south, but a male from Flagstaff, Arizona, as well as material from Meadow Valley, Mexico, suggests that the species may extend along the foothill regions into the Arizona and Mexican plateaus.

Marginal localities include: Roundhill, Nova Scotia; St. John, New Brunswick; Bryson City, North Carolina; Atlanta, Georgia; Ozark Lake, Missouri; Manhattan, Kansas; southern Arizona; Mi'-waukee, Wisconsin; and Midland County, Michigan.

*Flight records:* The species has been recorded as flying between July 10 (New Jersey )and November 11 (North Carolina), reaching its maximum abundance during September and early October.

*Plant records: Aster multiflorus* and *Solidago* sp. are the only two plants this bee has been recorded as visiting. Robertson suggests it is oligotropic on Compositae.

The types from Connecticut and Illinois are in the Academy of Natural Sciences of Philadelphia.

### *Colletes compactus hesperius* Swenk

*Colletes hesperius* Swenk, 1906, Ent. News, vol. 17, p. 257.
*Colletes compactus hesperius*, Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 28; Gibson and Criddle, 1921, 50th Rept. Ent. Soc. Ontario, p. 131.
*Colletes compactus*, Timberlake (not Cresson), 1951, Wasmann J. Biol., vol. 9, p. 196.

The form, originally described by Swenk in 1906, was reduced to subspecific rank in 1908. *C. c. hesperius* has the black pile of the body reduced and even absent in some cases, and although there is considerable variation in size, both sexes are larger than their eastern counterparts. There is some question as to the exact area of intergradation of these two subspecies, for specimens from Flagstaff, Arizona; Meadow Valley, Chihuahua, Mexico; and Golden, Colorado, all exhibit characters intermediate between the Washington type and typical *c. compactus.* A single male taken at Flagstaff, Arizona, resembles *c. compactus* closely except for a slight reduction in the amount of black pile present on the head and thoracic dorsum. Another male from Murray, Utah, has the black pile absent from the head and present only on the mesoscutum and scutellum; this cline appears to terminate in the more northerly specimens from Washington and British Columbia, which have the pile of the body all white except for a few dark hairs on the scutellum. The length and density of the pile of the body varies inversely with the presence of black.

In the females this feature is even more evident. Although I have seen no Arizona material, two females from Escalante and Bryce Canyon, Utah, have a strong admixture of black pile on the mesoscutum and vertex. The ratio of black to white decreases in material from northern Utah and southern Oregon, where the pile of the inner orbital margins is tawny grey to dusky and that of the vertex dusky with a few black hairs intermixed.

The single female from Chimney Gulch, Golden, Colorado, deviates strongly from *c. compactus* of the western plains and bears a close resemblance to material from Washington and British Columbia, for there is no black pile on the vertex nor along the inner orbital margins and the pile of the mesoscutum is predominantly dusky to tawny grey.

*Male:* Similar to *c. compactus* except in having inner orbital margins with a few dark hairs, not black; mesoscutum and scutellum with few black hairs; apical metasomal fasciae broader and denser; malar spaces one and one-fourth times as long as broad.

*Female:* As in *c. compactus* except in having face with no dark pile and much larger (14-15 mm.); vertex with few to no black hairs; mesoscutum and scutellum with black pile restricted to median discal area; malar spaces slightly longer, about one-half as long as broad; second metasomal tergum sharply depressed basally, containing a broad basal fascia at least as wide as apical fascia.

*Distribution:* Arizona: Flagstaff. Utah: Bryce Canyon; Escalante; Murray; Springville; Granger; Taylorsville; Mills. Idaho: Parma. California: Old Station, Shasta County; Gazelle, Siskiyou County; Mohave Desert. Oregon: Echo; Rufus, Sherman County. Washington: Hunt's Junction; Almota, Whitman County; Yakima. British Columbia: Oliver; Walhachin; Vernon; Penticton; Lillooet; Okanagan. Colorado: Chimney Gulch, Golden.

*Flight records:* The species has been taken between August 30 and October 15.

The types from Almota, Whitman County, Washington, are in the collections of the University of Nebraska.

## Group III—*latitarsis*

### *Colletes latitarsis* Robertson

(Fig. 10)

*Colletes latitarsis* Robertson, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 60; 1892, Trans. Acad. Sci. St. Louis, vol. 5, p. 571; 1904, Canadian Ent., vol. 36, p. 275; 1906, Science, vol. 23, p. 309; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 17; Graenicher, 1910, Bull. Publ. Mus. Milwaukee, vol. 1, p. 228; Banks, 1912, Ent. News, vol. 23, p. 107; Robertson, 1926, Ecology, vol. 7, p. 387; 1926, Psyche, vol. 33, p. 116; Leonard, 1926, Cornell Agric. Exper. Sta. Mem., no. 101, p. 1021; Robertson, 1928, Flowers and Insects, p. 10; Graenicher, 1930, Ann. Ent. Soc. Amer., vol. 23, p. 154; Pearson, 1933, Ecolog. Monog., vol. 3, p. 384; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301; Brimley, 1938, Insects of North Carolina, p. 451.

This species is distinctive but may be confused with *willistoni* Robertson. The males can readily be distinguished by having the posterior basitarsi two and one-fourth times as long as broad and by having the fifth sternal segment with its posterior margin strongly curved anteriorly from two posterior lateral angles. The female has the second tarsal segment of each hind leg short, approximately as long as broad, whereas the same segment in *willistoni* is one and one-half times as long as broad. In the female of *latitarsis* the posterior basitarsi are very broad, about two and one-fourth times as long as broad and the posterior tibiae are clothed with a mixture of grey and black pile.

*Male:* length 9.5 mm., wing length 6.25 mm.

Face with pile pure white, long, and dense about antennal bases and along inner orbital margins; clypeus bare except for a few long hairs overhanging from lateral margins; vertex with a few, dark, long hairs, but predominantly short, white pile; genal areas with pile pure white, becoming much longer and whiter on lower regions; mesoscutum with strong admixture of black and white pile; scutellum with the disc predominantly covered with black pile, lateral and posterior margins with fringe of longer, pure white pile; mesepisterna with the pile long, fine, and white; propodeum with strong clump of black and white pile on lateroposterior margins, lateral and posterior faces of propodeum with short, white pile not concealing surface; anterior femora and tibiae with very long, white pile, second and third pairs of legs with the pile short, sparse, and pale grey; metasomal terga one to five with broad, white apical fasciae; first metasomal tergum with dense lateral fringes of white pile extending to fascia, anterior face and discal area with abundant, erect, fine, white pile not concealing surface; metasomal terga two to five with abundant, short, deep fuscous to black pile on disc;

metasomal tergum six with pile semiappressed and deep golden; metasomal sterna one to five with apical fringes of ochreus pile, almost comblike; tergosternal margins with abundant black pile; metasomal sternum five with apical fringe of deep fuscous to black pile.

Antennae short, reddish brown, middle flagellar segments short, as long as broad; malar spaces seven-eighths as long as broad; clypeus flattened with shallow longitudinal median sulcus, surface shiny with a number of obscure longitudinal punctures; vertex shiny with scattered fine punctures. Prothoracic spines long and sharp, longer than width across base; mesoscutum closely and coarsely punctate, punctures almost contiguous over entire surface with shiny, almost linear, interspaces, impunctate area absent; scutellum with anterior surface sparsely punctate with fine punctures, punctures becoming coarser and more dense toward posterior margin, interspaces shiny; mesepisterna deeply and coarsely punctate, punctures almost contiguous above, tending to one-half puncture width apart below; propodeum with basal area deeply, quadrately pitted, lateral and posterior faces shiny and weakly striate, posterior face separated from lateral by weak longitudinal striae; tegulae deep brown; wings dusky with abundant, short, fine, brown pubescence, nervures brown; legs brown; posterior basitarsi two and one-fourth times as long as broad. Metasomal terga one and two deeply punctate with punctures varying from one to two puncture widths apart, becoming finer and denser toward extreme apical margins; metasomal terga three to five shiny and weakly folliculated; metasomal sterna shiny with apical margins of metasomal terga three and four weakly emarginate medially; metasomal sternum five strongly excavated from two lateral margins; seventh ventral plates as illustrated (fig. 10).

*Female:* length 10 mm., wing length 6 mm.

Face with pile white, short, and concentrated principally along lower inner orbital margins; clypeus bare; vertex with mixture of black and white pile; genal areas with pile short and pure white; mesoscutum with mixture of black and white pile over entire disc; scutellum with the disc completely covered with short, black pile, lateral and posterior margins with a fringe of short, white pile; mesepisterna with pile fine and white; pre-episterna with mixture of black and white pile; propodeum with lateral and posterior faces having abundant, short, white pile not concealing surface, latero-posterior margins with strong clump of pure white pile; legs with pile pale grey to deep fuscous, posterior femora and tibiae with pile

mainly black; metasomal terga one to four with apical fasciae pure white; first metasomal tergum with weak lateral fringes of white pile, disc with few, fine, white, erect hairs; metasomal terga three to five with discs covered with short, fine, erect, black pile; metasomal tergum six with pile semiappressed, black to deep golden; metasomal sterna with mixture of erect, black and ochreus pile, not fasciated.

Antennae brown, short; flagellar segments three-fourths as long as broad; malar spaces one-third as long as broad; clypeus flattened with a deep median longitudinal sulcus, shiny with elongate obscure punctures; vertex shiny and sparsely punctate. Prothoracic spines long and sharp, longer than width across base; mesoscutum very coarsely, densely punctate with punctures one-half puncture width apart, almost contiguous on extreme anterior and lateral faces, impunctate area absent; scutellum with punctures smaller on anterior one third, becoming larger and much more dense toward posterior face; mesepisterna shiny, deeply punctate with punctures approximately one-half puncture width apart; propodeum with the basal area deeply, quadrately pitted, lateral and posterior faces dull and finely striate; tegulae deep brown; wings dusky with abundant, fine, brown pubescence, nervures brownish black; legs reddish brown; posterior basitarsi two and one-half times as long as broad; second tarsal segment of hind leg as long as broad at widest points. Metasomal tergum one closely and deeply punctate over entire surface, becoming finer and denser on extreme apical margins; metasomal tergum two with punctures much finer and denser than those of first; metasomal terga three to five densely folliculated; metasomal sterna dull and finely and densely folliculated; metasomal sterna four and five with apical margins emarginate medially.

*Distribution:* The species is sparingly distributed over eastern America to the tablelands of Arizona. Marginal areas include: Forsythe, Montana; Pierre, South Dakota; Faribault, Minnesota; St. Croix County, Wisconsin; Douglas Lake, Michigan; South Miami, Florida; West Point, Mississippi; Quemada, Texas; Huachuca, Arizona; and Wray, Colorado.

*Flight records:* Records from Florida and Texas indicate the species begins flying in March and continues until August. With the increase in latitude to the north and altitude to the southwest the emergences are retarded with the latest seasonal record as September 29 from a Carlinville, Illinois, specimen. The main flights occur during July, August, and early September.

*Plant records:* The bee principally visits members of the genus *Physalis* but is not oligotropic on that group. Records include: *Asclepias incarnata, Ceanothus americanus, Medicago sativa, Melilotus alba, Physalis lanceolata, P. virginiana, Polygonum hydropiper, Solidago,* and *Symphoricarpos occidentalis.*

Specimen number 8987, a female, bearing a "Type" label printed in red, is hereby designated lectotype, and a male, lacking a number and collection data but bearing a written "Type" label, is designated lectoallotype.

The lectotypes from Illinois are in the collection of the Illinois State Natural History Survey.

*Colletes punctipennis maurus* subsp. nov.

(Fig. 11)

*Colletes punctipennis,* Cockerell (not Cresson), 1914, Ann. Mag. Nat. Hist., ser. 8, vol. 14, p. 11; 1917, Ann. Mag. Nat. Hist., ser. 8, vol. 19, p. 481.

This species was originally described by Cresson from specimens taken in Mexico south of Mexico City. An examination of the original description and of a male from Yucatan convinces me that Texas specimens exhibit sufficient differences to merit subspecific recognition. The pile of the face, mesothorax, and tibiae is strongly intermixed with black pile whereas *p. punctipennis* has no black hair in these areas. The prothoracic spines of *p. maurus* are shorter and more nearly triangular and the puncturation of the vertex is more distinct. Generally the pile of the body has a much greater intermixture of black in the Texas specimens, and the isolation of this subtropical area in the Brownsville region may restrict the dark population to a very small locale.

*Male:* length 11.5 mm., wing length 8.5 mm.

Pile of face predominantly long and white about antennal bases and along inner orbital margins; clypeus with a few, overhanging, long, pale grey to white hairs, a strong admixture of erect, black pile laterad and ventrad to antennal bases; vertex with pile black mixed among finer, pale grey pile; upper genal areas with pile short, pale grey, with a few dark intermixed hairs, pile becoming much longer, denser, and whiter below; mesoscutum with a very strong admixture of black and pale grey pile over entire surface; scutellum with pile predominantly black except for a weak peripheral fringe of white pile; mesepisterna with an admixture of black and pale grey pile above, pile becoming longer, finer, and whiter below; propodeum with a dense fringe of long, pale grey and black pile at upper lateroposterior surfaces, lateral and posterior faces with

pile shorter and whiter; pile of legs long and rather sparse with almost equal quantity of black and white pile intermixed; first metasomal tergum with apical fascia very weak and narrow, often interrupted medially, pile forming a weak white fringe, lateral fringes of pile weak, short, and white, barely reaching apical fascia, disc with sparse, erect, pale grey pile; metasomal terga two to four with fasciae very weak, narrow, and white, often interrupted medially; metasomal terga two to six with abundant, erect, black pile on discal areas; metasomal sterna with a weak covering of fine, dark pile, particularly on apical portions of each sternum.

Antennae long, yellowish brown below to deep brown-black above; malar spaces five-eighths as long as broad; clypeus with a deep longitudinal median sulcus, most evident at central portion, surface very coarsely, striately punctate to apex, interspaces shiny; vertex dull, finely and densely punctate; fascial foveae distinctly depressed above, barely reaching to top of inner margin of compound eyes. Prothoracic spines roughly triangular, barely as long as width across base; mesoscutum very coarsely and densely punctate, almost contiguous anteriorly to one-half puncture width apart posteriorly, impunctate area absent; scutellum very densely and coarsely punctate to anterior margin, punctures contiguous and not at all striate; mesepisterna deeply, coarsely punctate, punctures one-half puncture width apart with shiny interspaces; propodeum with basal area deeply, longitudinally quadrate, lateral and posterior faces dull and roughened; tegulae deep brownish black; wings dusky with abundant, long, deep fulvous pubescence over entire surface, wings pictured, pictures extending posterior to the stigma and apically from radial sector to anteroapical margin, weakly pictured about apical ends of veins, median one and cubitus one; legs extremely robust, deep black; posterior basitarsi twice as long as broad. First metasomal tergum very densely and coarsely punctate, punctures one-half to one puncture width apart, interspaces shiny, a weak elevated median impunctate longitudinal ridge; second metasomal tergum with punctures slightly finer and denser than those of first tergum, not more than one-half puncture width apart, tergum abruptly depressed basally; apical fasciae of metasomal terga two to four lying in smooth, black, impunctate margins; metasomal sterna with apical portions finely folliculated, discal areas shiny; seventh ventral plates and capsule complex, much as in *latitarsis* (fig. 11).

*Distribution:* Holotype, male, Brownsville, Texas, July 3, 1938 (R. H. Beamer); paratypes, 3 males, Brownsville, Texas, October

16, 1908 (Mitchell and Bishop); Palm Forest, Brownsville, Texas, March 27, 1951 (R. H. Beamer); Brownsville, Texas, January 2 to13, 1928.

The holotype is in the Snow Entomological Collections of the University of Kansas.

### GROUP IV—*simulans*

### *Colletes simulans* Cresson

This species most closely resembles *fulgidus* Swenk, particularly in the western part of its range, where the females are at times barely distinguishable. The mountain representatives of *simulans* differ slightly from *fulgidus* in having the puncturation of the first metasomal tergum much closer and coarser; however, there are exceptions to this, and the only accurate method of determination is by genitalic examination of the males. The penis valves of *simulans* are broad, truncate apically, and the gonostyli are slightly more than four times as long as their apical width. In *fulgidus* the penis valves are weakly rounded and the gonostyli are three times as long as broad measured at the same position. The seventh ventral plates of *simulans* vary greatly in the regions between the western part of the Great Plains and California. Generally they are much broader and have long lateral basal projections near the basal hair tufts in the west and north. As Timberlake suggests, the trapezoidal shape of the seventh ventral plate is exaggerated in the Swenk illustration from California; however, the more northerly material from Wyoming, Montana, and British Columbia comes closer to that illustrated, suggesting there may be a north-south cline in this character rather than the east-west variability suggested by others. In addition to the puncturation of the first metasomal tergum, the females differ from *fulgidus* in having the precoxal spines approximately four times as long as broad, and the scutellum with many longitudinal striae over the posterior three-fourths of the surface.

*Male:* length 10 mm., wing length 7 mm.

Pile of face rather long and pale, concealing clypeus; pile of vertex and upper genal areas variable, becoming much longer, finer, and pure white below; mesoscutum and scutellum with abundant, long, erect pubescence, weakly tinged with ochreus and occasionally mixed with black pile on mesoscutel and scutellar discs; pile of mesepisterna long, fine, and light grey; propodeum with long, dense fringes of pale grey pile at lateroposterior margins, extending halfway down to pedicle, lateral and posterior faces sparsely covered

with erect, pale grey pile; legs with pile sparse, long, and white to pale grey; first metasomal tergum with apical fascia weak, rather narrow, and pale grey, lateral fringes of pile extending to the apical fascia, sometimes interrupted towards apex, discal area with abundant, long, erect, pale grey pile, not at all concealing surface; metasomal terga two to five with fasciae broad and white; metasomal sterna with very narrow apical fasciae of short, white pubescence.

Antennae long, deep reddish brown, flagellar segments approximately one and one-half times as long as broad; malar spaces five-eighths as long as broad; clypeus weakly convex, finely and densely punctate over the basal one-half and down a median longitudinal line, punctures not at all striate, the apicolateral margins shiny, sparsely punctate with weak striate punctures; vertex dull, densely punctate. Prothoracic spines short and roughly triangular; mesoscutum densely, coarsely punctate over anterior one half and lateral margins; scutellum with discal area sparsely punctate with shiny interspaces, punctures approximately one to two puncture widths apart, becoming much sparser towards anterior margin; wings dusky, nervures brown; legs deep brown to black; posterior basitarsi four times as long as broad. Second metasomal tergum with a distinct basal depression; seventh ventral plates roughly quadrate, expanded or lobate towards the apical end, a long, lateral projection from the basal area of each plate; penis valves broadly truncate apically; gonostyli slightly more than four times as long as apical width.

*Female:* length 11:5 mm., wing length 8.25 mm.

Pile of face erect, sparse, and pale grey, concentrated principally about antennal bases; vertex with some dark pile intermixed; mesoscutum with dense fringes of light ochreus pile about anterior one fourth and lateral margins, discal area with abundant, black, erect pile; scutellum with a peripheral fringe of light ochreus pile, discal area with abundant, erect, black pile; mesepisterna with pile tinged with ochreus above, becoming much longer and whiter below; pile of legs long and tinged with ochreus; first metasomal tergum with a very narrow, weak apical fascia, evident only laterally, lateral fringes rather weak, evident only on anterior lateral face, not usually reaching apical fascia, discal area sparsely covered with a few pale grey hairs; metasomal terga two to five with fasciae broad and white, second metasomal tergum with distinct basal fascia of white pubescence; metasomal sterna two to four with very weak fringes of light ochreus pile, not at all fasciate.

Antennae reddish brown, flagellar segments approximately as long as broad; malar spaces one fourth as long as broad; clypeus weakly convex, very coarsely and striately punctate to apex, interspaces shiny; vertex finely punctate with shiny interspaces. Prothoracic spines long; mesoscutum very coarsely, densely, almost rugosely punctate over anterior one half and lateral margins, surface dull, impunctate area very small; scutellum rather densely and striately punctate, striae extending towards anterior margin, dull, striate punctures almost reaching anterior margin; mesepisterna very coarsely and densely punctate, punctures contiguous above, becoming slightly sparser below, dull; propodeum with basal area quadrately pitted, lateral faces shiny and weakly sculptured, posterior face dull and roughened; wings dusky with abundant, light ochreus pubescence apically, nervures brown; legs deep reddish brown; posterior basitarsi three times as long as broad. Metasomal sterna shiny, finely and sparsely folliculated.

It is difficult to separate the subspecies of *simulans* on the basis of the named forms. The division into the four subspecies which follows is not entirely satisfactory since *simulans* was originally described from specimens labeled merely "Colorado" and exhibiting features intermediate between two of the subspecies. I believe the typical material to be most characteristic of the Rocky Mountain subspecies and therefore have recognized *simulans simulans* as the form occurring in the mountainous regions from Arizona and New Mexico north into Montana. A rather good representation of this subspecies from the mountains of Arizona and western New Mexico has the mesoscutum devoid of any dark hairs and the seventh ventral plates more strongly lobate than in those specimens occurring in the northern portion of the Great Divide. Specimens from Zion National Park in southern Utah are basically similar to the Arizona material but in northern Utah, Nevada, and western Colorado the dark hair of the mesoscutum becomes more prominent and the seventh ventral plates much more trapezoidal. This increase in the amount of black pile and the more trapezoidal shape of the seventh ventral plates progresses to the north, with the plates becoming widest in specimens taken from the valleys of Washington and British Columbia. The females taken in Arizona exhibit a marked difference from other populations of this species in having the prothoracic spines roughly triangular and strongly tending towards obliqueness. The first metasomal tergum of *s. simulans* is much more coarsely punctate than the others and the pile of the scutellum and the mesoscutum is predominantly ochreus to ochreus

grey. The oblique nature of the prothoracic spines is found in much of the material taken in Colorado, particularly in specimens from the higher altitudes between 4000 and 9000 feet, and this tendency is also evident in some of the southern Utah specimens.

The obliqueness of the prothoracic spines is lost in *s. nevadensis* occurring in California, Oregon, Washington, and British Columbia, where the spines are long and sharp.

The more northerly material found from the foothill regions east of the Continental Divide to the Atlantic seaboard I have considered as mostly *armatus* Patton, with *s. miamiensis* or intergrades toward it occurring in the extreme south. Two males from El Paso, Texas, are intermediate between *s. simulans* and *s. miamiensis* genitalically but differ from *s. simulans* in having much less dark hair on the mesoscutum and scutellum; in fact there are only a few darker hairs intermixed on the scutellar disc. Several specimens representing both sexes have been taken at Hattiesburg, Mississippi, and prove to be an intermediate form between those from El Paso and those from Florida, *s. miamiensis* Mitchell.

Were it not for the abundance of black pile on the thoracic dorsum and the long, sharp prothoracic spines of the eastern *armatus*, this subspecies would be very difficult to distinguish from the populations of *s. simulans* occupying the Arizona-New Mexico plateaus. In the material taken from the foothill regions of Texas, Nebraska, and the Dakotas, the prothoracic spines lose the oblique nature of *s. simulans* completely and become much longer and sharper. Accompanying this elongation of the spines there is a progressive increase in the amount of black pile on the mesoscutum, scutellum, and the vertex of the head, reaching a stage of almost completely black along the Atlantic seaboard. Here, too, the prothoracic spines reach their greatest length, extending laterally well out beyond the edges of the head.

Thus examination of the two sexes suggests that the entire group may have spread from the southwestern area and moved north, west, and east to occupy North America. The absence of any closely related species in the Palearctic region (Noskiewicz, 1936) tends to substantiate the southerly origin of this complex. (Map 1.)

### *Colletes simulans simulans* Cresson

(Fig. 12)

*Colletes simulans* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 168; Cockerell, 1898, Zool., ser. 4, vol. 2, p. 313; Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 57; Swenk, 1904, Canadian Ent., vol. 36, p. 94; Cockerell, 1905, Psyche, vol. 12, p. 86; 1906, Trans. Amer. Ent. Soc., vol. 30, p. 291; Cresson, 1916, Mem. Amer. Ent. Soc., no. 1, p. 109; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 397.

*Colletes armata*, Cockerell (not Patton), 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 41; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 21; 1898, Zool., ser. 4, vol. 2, p. 311; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1899, Ent. News, vol. 10, p. 4; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292.

*Colletes bigeloviae* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 40; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 21; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1899, Entom., vol. 32, p. 155; 1901, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 125; Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 62; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 53; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 397.

*Colletes brevispinosus* Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 62; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 54; Cresson, 1928, Mem. Amer. Ent. Soc., no. 5, p. 58; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 397.

*Colletes coloradensis* Cockerell, 1933, Ann. Ent. Soc. Amer., vol. 26, p. 41; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 397.

*Colletes tegularis* Swenk, 1905, Canadian Ent., vol. 37, p. 304; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; Swenk, 1908, Univ. Nebraska Studies, vol. 1, p. 58; Criddle *et al.*, 1924, Rept. Ent. Soc. Ontario, p. 99; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 397.

The males of this subspecies have the pile of the mesoscutum and scutellum pale grey or tinged with light ochreus and a few dark hairs intermixed, these dark hairs not black. The tegulae and the nervures are a light hyaline brown. The first metasomal tergum is very densely and coarsely punctate with the punctures no more than one puncture width apart. The seventh ventral plates are roughly quadrate tending to weakly trapezoidal in the mountains of the Central States (fig. 12). The females have the prothoracic spines rather long and tending towards obliqueness apically, becoming much shorter and tending to be much more oblique in the mountains of New Mexico and Arizona, which at present is the southern known extremity of its range. The first metasomal tergum is very densely punctate, punctures no more than one puncture width apart.

*Distribution:* This subspecies ranges from Montana southward into the mountains of New Mexico and Arizona. It has been recorded from: Montana: Bozeman; Weeksville. Wyoming: Rock Springs; the mountains near Sheridan. Colorado: Creede; Glenwood Springs; Greeley; San Luis Valley; Wray. New Mexico: Albuquerque; Las Cruces; Sacramento Mountains; Mescalero; San Ignacio; Willow Creek. Arizona: Flagstaff; Grand Canyon; Houserock Valley; Humphrey's Peak; Oak Creek Canyon; Sabino Basin; Santa Catalina Mountains; San Pedro River, Fairbanks.

*Flight records:* Specimens have been caught during the period August 2 to September 23.

*Flower records: Aster, Bigelovia Wrightii, Grindelia, Senecio.*

The holotype of *simulans* from Colorado is in the Academy of

Natural Sciences of Philadelphia, that of *bigeloviae* from Mescalero, New Mexico, is in the United States National Museum, that of *brevispinosus* from Beulah, New Mexico, is in the collections of the Academy of Natural Sciences of Philadelphia, and that of *tegularis* from Gering, Scotts Bluff County, Nebraska, is at the University of Nebraska.

### *Colletes simulans miamiensis* Mitchell

*Colletes simulans armatus*, Michener, 1947, Amer. Midland Nat., vol. 38, p. 445.
*Colletes simulans miamiensis* Mitchell, 1951, J. Elisha Mitchell Sci. Soc., vol. 67, p. 236.

The subspecies, although found far from the Continental Divide, agrees more closely with *s. simulans* than *s. armatus*, but ranks as subspecifically distinct on the basis of few dark hairs on the thoracic dorsum, weakly truncate and short prothoracic spines, and denser pubescent covering of the wings. The seventh ventral plates resemble those of *s. simulans* in their shorter laterobasal projections and broad basal areas.

The suggested relationship to *s. simulans* is enhanced by the presence of intermediate forms from Hattiesburg, Mississippi, and El Paso, Texas, and the apparent absence of the species in the East South Central States.

On the basis of these data it appears that the Florida specimen represents the eastern terminus of an east-west cline extending through Texas and the southern states.

This monotype was examined only once and unfortunately returned before an adequate description was compiled. To supplement the notes made at the time of examination, the original description follows.

"Male—Length 9 mm.; length and breadth of face subequal; eyes convergent below; length of malar space about one-third its breadth; length of antennal segments about 1½ times their breadth, basal segment of flagellum much shorter than the second, flagellum brownish, but the basal segment much darker; clypeus closely and deeply punctate, upper portion hidden by the dense pubescence; face above antennae dull, rugoso-punctate, vertex shining, finely and irregularly punctured; cheeks closely and finely punctate beneath the copious pubescence; pubescence whitish on head and thorax, slightly yellowish above, mesonotum and scutellum with a few inconspicuous, fuscous hairs; lateral angles of prothorax not spined; metapleural protuberance not carinate; legs dark, metatarsi slender; spurs yellowish; tegulae yellowish-ferruginous; wings lightly infuscated, nervures and stigma piceous; third submarginal cell slightly

exceeding the second, the latter receiving first recurrent slightly basad of middle, third receiving second recurrent about one-third from tip; punctures of mesonotum deep and coarse, close over most of disc, but sparse in center of posterior half; scutellum shining, coarsely and deeply punctate, anterior margin impunctate, but punctures quite close along hind margin; pleura dull, rugoso-punctate anteriorly and above, with more distinct but close and coarse punctures below; lateral and posterior faces of propodeum coarsely reticulate, dorsal face short, with closely parallel striae; base of abdomen deeply and distinctly but finely punctate, punctures well separated but not sparse; second and following terga becoming successively more minutely and closely punctate; apical margins of terga slightly depressed, reddish-hyaline beneath the thin, white fasciae, discal pubescence on second and following terga fuscous, very short, suberect and inconspicuous; seventh sternum and genital armature essentially the same as in the other forms of *simulans*.

"Holotype: Male, Miami, Fla., Jan. 21, 1924 (J. Pearson) Am. Mus."

### *Colletes simulans armatus* Patton

(Fig. 14)

*Colletes inaequalis*, Cresson (not Say), 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 166; 1872, Trans. Amer. Ent. Soc., vol. 4, p. 248.

*Colletes armata* Patton, 1879, Proc. Boston Soc. Nat. Hist., vol. 20, p. 143; 1879, Bull. U. S. Geol. Geog. Survey, ser. 5, no. 3, p. 365; Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 116; Bridwell, 1899, Trans. Kansas Acad. Sci., vol. 16, p. 209; Pierce, 1904, Univ. Nebraska Studies, vol. 4, p. 24; Morice, 1904, Trans. Ent. Soc. London, p. 27, pl. 9, fig. 57, 58 (Colletes sp.?); Robertson, 1904, Canadian Ent., vol. 36, p. 275; 1906, Science, vol. 23, p. 309; Lovell, 1907, Canadian Ent., vol. 29, p. 364; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 53; Graenicher, 1910, Bull. Pub. Mus. Milwaukee, vol. 1, p. 228; Smith, 1910, Ann. Rept. New Jersey State Mus. for 1909, p. 694; Robertson, 1914, Ent. News, vol. 25, p. 69; Gibson, 1914, Rept. Ent. Soc. Ontario, p. 124; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario, p. 131; Robertson, 1926, Ecology, vol. 7, p. 387; 1926, Psyche, vol. 33, p. 116; Leonard, 1926, Cornell Agric. Exper. Sta. Mem., no. 101, p. 1021; Robertson, 1928, Flowers and Insects, p. 10; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301; Brimley, 1938, Insects of North Carolina, p. 451; Proctor, 1938, Biol. Surv. Mount Desert Region, pt. 6, p. 440 & pt. 8, p. 503; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 397 (*simulans* sbsp.).

*Colletes scitula* Patton, 1879, Proc. Boston Soc. Nat. Hist., vol. 20, p. 144; Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 116.

*Colletes spinosa* Robertson, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 60; 1895, Trans. Amer. Ent. Soc., vol. 22, p. 116.

The Swenk (1908) synonymy in which he lists *bigeloviae* and *brevispinosus* as *armatus* is in error and as Timberlake (1943) suggests they are synonyms for the better known *simulans simulans*.

The males have black hair intermixed on the vertex, mesoscutum,

and scutellum. The prothoracic spines are long and sharp, approximately one and one-half times as long as the width across the base. The mesepisterna are obscurely punctate and roughened, and the first metasomal tergum is very finely punctate, with punctures two to three puncture widths apart. In many specimens there is an admixture of black pile along the lower inner orbital margins. The seventh ventral plates are particularly quadrate and lobate apically (Figure 14).

In the females the pile of the vertex, the mesoscutum, and the scutellum is predominantly black. The prothoracic spines are very long and sharp, protruding well beyond the sides of the head; the fascial foveae are deep and shiny; the tegulae are deep brown, almost black; the scutellum is more striate than punctate to the anterior margin; and the mesepisterna are more coarsely punctate.

*Distribution:* This species is found in abundance throughout the northern Great Plains to the Atlantic seaboard, recorded southward to North Carolina. Marginal localities include King's County, Nova Scotia; Fort Coulonge, Quebec; Aweme, Manitoba; Bilby, Alberta; Malcolm, Nebraska; and Raleigh, North Carolina.

*Flight records:* The subspecies flies from August 2 until October 1.

*Plant records: Aster, Solidago, Solidago nemoralis.*

A female, Pelham, N. H., September 2, 1905 (Bridwell) and a male, Nelson, N. H., August 1, 1907, are hereby designated neotype and neallotype of *armatus.* Both are in the collections of the United States National Museum. A female, number 9697, and a male, number 6876, both from Illinois, are hereby designated lectotype and lectoallotype of *spinosa,* and are in the Illinois Natural History Survey Collections.

### *Colletes simulans nevadensis* Swenk

(Fig. 13)

*Colletes nevadensis* Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 52.
*Colletes simulans nevadensis* Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 402; 1951, Wasmann J. Biol., vol. 9, p. 207.

The male has the pile of the face, the thorax, and the abdomen weakly tinged with light yellow, the pubescence, particularly the fasciae, is denser and the fasciae somewhat broader. The prothoracic spines are slightly longer than the width across the base. The seventh ventral plates are trapezoidal in shape, much more so than the quadrate form from the southwestern mountains (Fig. 13). The malar spaces are slightly reduced, being scarcely half as long as wide.

The female has the pile of the body weakly tinged with yellow. The malar spaces are slightly reduced. The prothoracic spines are long and sharp, protruding to the edge of the head. The first metasomal tergum has the punctures finer and slightly sparser, ranging from two to three puncture widths apart.

*Distribution:* The subspecies is found in the lowland areas of Utah, Nevada, California, Washington, Oregon, and British Columbia. It undoubtedly occurs in the valleys of Idaho and possibly western Colorado but has not yet been taken there. Peripheral localities include: Penticton and Oliver in British Columbia, Riverside and Los Angeles Counties, in California, and Salt Lake City and Emery County in Utah.

*Flight records:* Flight records are from August 7 until November 26. A great number of specimens determined as *nevadensis* taken particularly from the mountains of California have proved to be *fulgidus* Swenk. I believe *simulans nevadensis* to occur only in the lowland areas, being replaced by *fulgidus* in the mountains.

*Plant records: Baccharis emoryi, Chrysothamnus, Ericameria ericoides, Eriogonum, Gutierrezia californica, Aplopappus* (*Isocoma*) *veneta* var. *vernonioides, Lepidospartum, Melilotus alba.*

The holotype from Reno, Nevada, is in the collections of the University of Nebraska.

### *Colletes angelicus* Cockerell

(Fig. 15)

*Colletes angelicus* Cockerell, 1905, Bull. So. California Acad. Sci., vol. 4, p. 32; Criddle *et al.*, 1924, Rept. Ent. Soc. Ontario, p. 99 (doubtful record); Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 402.

Both sexes of this species can readily be distinguished by having the prothoracic spines obliquely truncate and by having their posterior margins protruding to or beyond the anterior. It most closely resembles *fulgidus* Swenk. Criddle *et al.* reported *angelicus* from British Columbia in 1924. I doubt the validity of this determination although to my knowledge I do not have their specimen before me. The species seems to be restricted to southern California where it appears to replace *fulgidus.* The male genitalia closely resemble those of *fulgidus* except for minor differences in the hair pattern. Some variation exists in the presence of black pile on the mesoscutum and scutellum. In all specimens having a deep ochreus pile on the thoracic dorsum dark hairs are evident; however in those having the pile grey, dark hairs are not discernible. This would seem to indicate that the dark pile is deep ochreus rather than black.

In the majority of the males the sternal fasciae are continuous, however in a few the fasciae are interrupted medially. The female can be readily separated from other members of the *simulans* group on the basis of the prothoracic spine peculiarity and the very long procoxal spines.

*Male:* length 11 mm., wing length 7.5 mm.

Pile of face dense and long, tinged with yellow, completely concealing clypeus and extending just slightly above antennal bases; pile of vertex and upper genal areas pale grey, pile becoming much longer and whiter below; mesoscutum with abundant, long, erect pile slightly tinged with ochreus, a few darker hairs on discal area of the mesoscutum; scutellum with pile principally pale grey to light to tinged with yellow, having a few dark, almost black, hairs intermixed; mesepisterna with pile long, fine, and pale grey; propodeum with dense lateroposterior fringes of pale grey pile, lateral and posterior faces with abundant, erect, pale grey pile; legs with pile sparse, short and light; first metasomal tergum with fascia weakly tinged with yellow and complete with rather long hairs, lateral fringes pale grey, extending to the fascia, disc with abundant, erect, pale grey pile; metasomal terga two to five with fasciae much broader than first and much more white, fasciae very dense; terga three to six with discs having abundant, erect, light pile, not black; metasomal sterna with fasciae uniform and complete with a dense apical fringe.

Antennae deep brown to black, flagellar segments approximately one and one-half times as long as broad; malar spaces three-fourths as long as broad; clypeus weakly convex, rather finely and densely punctate over apical one half and down median portion, lateral apical aspects sparsely, striately punctate with shiny interspaces; the vertex finely and densely punctate, dull. Prothoracic spines obliquely truncate with posterior margin descending beyond anterior; mesoscutum densely punctate, impunctate area very small; scutellum densely, coarsely, almost rugosely punctate over posterior one-third, punctures becoming sparser with shiny interspaces over median portion, anterior face shiny, impunctate; mesepisterna densely punctate, punctures no more than one-half puncture width apart; propodeum with basal area deeply, quadrately pitted, lateral and posterior faces dull and roughened; tegulae brown; wings with very sparse, light ochreus pubescence tending to be almost whi'ish hyaline basally, nervures brown; legs reddish brown to black; posterior basitarsi four and one-half times as long as broad. First metasomal tergum densely punctate with punctures one to two

puncture widths apart; second metasomal tergum with punctures finer and denser, no more than one puncture width apart, tergum having an abrupt basal depression; metasomal terga one to four with fasciae lying in broad, depressed apical margins, these depressed margins light brownish hyaline; sterna shiny, rather weakly and sparsely folliculated; the seventh ventral plates resemble *fulgidus* but much narrower and more elongate (fig. 15).

*Female:* length 11 mm., wing length 8 mm.

Pile of face erect and pale grey, clumped principally about antennal bases; vertex with pile tinged with ochreus, pile becoming longer and pale grey below; mesoscutum with pile pale grey to light ochreus intermixed with abundant black pile on discal area; scutellum with an admixture of light ochreus and black pile about peripheral margins; mesepisterna with pile long, fine, and pale grey; propodeum with dense fringes of pile along lateroposterior margins extending down towards pedicel, lateral and posterior faces with abundant, erect, pale grey pile; pile of legs light ochreus, long, and dense; first metasomal tergum with apical fasciae weak and narrow, easily removed, lateral fringes of light ochreus pile extending to fascia, discal area with scattered, pale grey pile, particularly on anterior face; metasomal terga two to five with fasciae broad and rather dense, second metasomal tergum with a broad basal fascia; terga three to six with the discs having scattered, ochreus to deep testaceous, erect pile, not at all concealing surface; metasomal sterna two to five with weak lateral clumps of pile, not continuous through middle.

Antennae reddish brown, flagellar segments seven-eighths as long as broad; malar spaces three-eighths as long as broad; clypeus weakly convex, densely, striately punctate to the apex; fascial foveae greatly broadened above and deep, extending over half way to lateral ocelli; vertex shiny with many fine punctures. Prothoracic spines obliquely truncate with posterior margin descending beyond anterior; mesoscutum very coarsely almost contiguously punctate on median area, impunctate area very small; scutellum very coarsely and densely punctate over posterior one half, anterior half with punctures sparse and almost absent, a deep median longitudinal sulcus extending almost to anterior margin; mesepisterna dull and very coarsely and contiguously punctate; tegulae deep brown; wings dusky with sparse, ochreus pubescence, nervures brown; legs deep reddish brown to black; posterior basitarsi four times as long as broad. First metasomal tergum rather densely punctate with fine punctures, punctures approximately one to two puncture widths

apart; second tergum with punctures very fine, folliclelike, and dense, apical fasciae in weakly depressed margins, fascial depressions hyaline; metasomal sterna sparsely folliculated with rather coarse follicles.

*Distribution:* California: Antioch; Contra Costa County; Berkeley; Riverside; Anaheim, Orange County; Morro Bay; Los Angeles.

*Flight records:* The species has been caught in abundance between August 21 and October 25 in southern and central California. However, I have two specimens from Berkeley, California, which were collected on April 20, 1937. This would indicate that the species has two generations or probably one and a partial spring generation.

*Plant records: Eriogonum, Hemizonia paniculata, Isocoma vernonioides.*

The holotype from California is in the collections of the Citrus Experiment Station, Riverside, California.

### *Colletes fulgidus fulgidus* Swenk

(Fig. 16)

*Colletes fulgidus* Swenk, 1904, *In* Viereck, Canadian Ent., vol. 36, p. 95; 1908, Univ. Nebraska Studies, vol. 8, p. 50; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario, p. 131; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 396.

This species ranges from California and Nevada across the southern Great Basin to the Rocky Mountains. Swenk recorded the species from Nebraska and Texas as well as other northern and far western states. I have not seen any specimens from either Nebraska or Texas other than a few females determined as *fulgidus* by him. These specimens are *louisae* Cockerell and *simulans simulans.* No males have as yet been taken from Nebraska, New Mexico, or Texas, where it is probably replaced by the more southerly *louisae.* The males of the species are difficult to distinguish without genitalic examination and even then a series of characters is necessary for accurate determination. This sex often shows considerable variation from the typical series, having the color of the thoracic pile varying from pale grey to light ochreus. The thoracic spines are rather blunt in some but rather long and sharp in others. A very few specimens lack dark pile on the mesoscutum and the scutellum, and in some there is a weak rudiment of a basal fascia on the second metasomal tergum. The females are difficult to segregate with certainty from *louisae* and some specimens show the first metasomal tergum rather coarsely punctate, bearing a close superficial resemblance to the *simulans* complex. While the typical material from

the Big Horn Mountains of Wyoming has an almost impunctate or weakly folliculated first tergum, other specimens from the western part of America show rather coarse but sparse puncturation. The second metasomal tergum, unlike that of *louisae,* is finely and densely folliculated. Similarly, the apical sterna of *fulgidus* are uniformly, finely folliculated, while the sterna of *louisae* have sparse, fine punctures restricted to the lateral and the extreme posterior surfaces.

*Male:* length 9 mm., wing length 6.5 mm.

Pile of face long, white, concealing clypeus and antennal basal area; vertex with pile light tinged with pale grey; upper genal areas with pile long and pale grey, becoming longer and more white below; mesoscutum with pile tinged with grey, long, erect, and fine; scutellum with pile pale grey to tinged with ochreus, a few darker hairs intermixed; mesepisterna with pile long, fine, and white; propodeum with weak fringes of long, pale grey pile on latero-posterior margins, lateral and posterior faces with a sparse covering of long, erect, pale grey pile; pile of legs very sparse, fine, and whitish; first metasomal tergum with apical fasciae narrow, composed of long, ragged, pale grey pubescence, lateral fringes of pale grey pile weak extending to apical fascia, discal area with abundant, erect, long, pale grey pile; metasomal terga two to five with fasciae composed of weak, ragged, white pubescence, discal areas of terga three to six with abundant, short, ochreus to grey pile, not at all concealing surface; metasomal sterna with apical fringes of short, white pile, slightly longer at extreme lateral margins.

Antennae reddish brown, flagellar segments one and one-fourth times as long as broad; malar spaces three fourths as long as broad; clypeus convex, finely and densely punctate over basal one half and down a flattened, median longitudinal line, not rugosely punctate, apicolateral faces shiny, impunctate; vertex distinctly punctate with shiny interspaces. Prothoracic spines long and sharp, about one and one-half times as long as width across base; mesoscutum rather finely punctate, punctures approximately one puncture width apart on anterior and lateral faces, becoming sparser in median discal area; scutellum coarsely punctate, punctures approximately one puncture width apart medially, becoming much sparser toward anterior face; mesepisterna rather finely punctate, punctures approximately one puncture width apart above to one and a half puncture widths below, interspaces shiny; propodeum with basal area deeply pitted, lateral and posterior faces dull and roughened; tegulae dark brown hyaline; wings dusky, nervures brown; legs

deep reddish brown; posterior basitarsi four and a half times as long as broad. First metasomal tergum deeply punctate with punctures one to two puncture widths apart, interspaces shiny; second metasomal tergum with punctures finer and closer, especially on anterior margin, tergum distinctly depressed basally; metasomal sterna shiny and sparsely folliculated on lateroposterior one half of each sternum; seventh ventral plates as illustrated (fig. 16).

*Female:* length 10.5 mm., wing length 7 mm.

Pile of face long, white and dense about antennal bases and middle inner orbital margins, a few long hairs overhanging clypeus; vertex with a few, light ochreus hairs, particularly in and about the ocellar triangle; upper genal areas with pile tinged with grey, becoming very fine and much longer below; mesoscutum with pile light ochreus about anterior and lateral margins, discal area with pile black; scutellum with a peripheral rim of pile tinged with ochreus, disc with abundant black pile; mesepisterna with pile long, fine and pale grey; legs with pile short, rather dense on posterior legs, and tinged with ochreus; first metasomal tergum with apical fascia weak, interrupted medially and evident only as a fascia at lateral one third, lateral fringes of pile dense, extending to apical fascia, discal area sparsely covered with erect, fine, pale grey pile; metasomal terga two to five with fasciae very broad, dense, and pure white, second metasomal tergum with a basal fascia interrupted medially; metasomal sterna with a few erect, pale grey hairs, not forming a fascia.

Antennae reddish brown, flagellar segments about as long as wide; malar spaces one-third as long as broad; clypeus flattened medially, coarsely, striately punctate to the apex, ridges and interspaces shiny; vertex shiny with a few scattered punctures. Prothoracic spines long, about twice as long as width across base, extending laterally to sides of the head; mesoscutum very densely and coarsely punctate over anterior one-half and lateral margins, impunctate area large; scutellum densely punctate about lateral and posterior faces, discal area sparsely and finely punctate with punctures anywhere from one to three puncture widths apart, anterior one-third shiny, impunctate; mesepisterna very densely, almost contiguously punctate; propodeum with deep, broad, quadrate pits, propodeum with lateral and posterior faces weakly rugose and shiny; tegulae deep brownish hyaline; wings dusky, nervures brown; legs deep brown; posterior basitarsi three and one-half times as long as broad. First metasomal tergum shiny, very weakly and sparsely punctate, punctures most dense laterally where they are

three to four puncture widths apart; second tergum shiny and sparsely folliculated; metasomal sterna densely folliculated over posterior one half of each sternum.

*Distribution:* The species is found in abundance in the higher regions of California, Oregon, Washington, Idaho, Montana, Wyoming, northern Utah, and Colorado, circumscribing the Great Basin region. Marginal localities are: Tonopah, Nevada; Bear Valley, San Bernardino County, California; Salmon Arm, British Columbia; Lethbridge, Alberta; Craters of the Moon, Idaho; Missoula, Montana; Custer, South Dakota; Aspen, Colorado; and Vernal, Utah.

*Flight records:* The species flies from May 7 until October 16, occurring in abundance during all the summer months.

*Plant records: Chaenactis sterioides, Clarkia, Encelia, Eriogonum, Grindelia, Isocoma vernonioides, Medicago sativa, Melilotus alba, Salix, Solidago.*

The holotype from the Big Horn Mountains, Wyoming, is in the collections of the University of Nebraska.

*Colletes fulgidus longiplumosus* sp. nov.

This subspecies formerly was included with *fulgidus fulgidus;* however it is readily distinguished in both sexes by the extremely long and dense pile of the head, thorax, and abdomen. The subspecies appears to be a coastal race of the generally montane *f. fulgidus* and has been collected from various localities along the Californian coast. The male differs from *f. fulgidus* in having the malar spaces as long as wide, the prothoracic spines vestigial, almost absent, the puncturation of the first metasomal tergum finer and sparser and the pile of the body very long, dense, and plumose. The black pile is evident on the scutellum and the mesoscutum. In the females of this subspecies the malar spaces are approximately one-half as long as broad; the prothoracic spines are roughly triangular and obtuse; and the pile, principally of the head and thorax is exceedingly long and plumose.

*Distribution:* The extreme western coastal region of California from Humboldt County to San Luis Obispo County, inland as far as Sacramento.

Holotype male, allotype female and 9 paratypes: Montara, San Mateo County, California, June 10, 1939 (C. D. Michener); paratypes: 27 males, Dillon Beach, Marin County, California, May 22, 1949 (W. W. Middlekauff); 1 male, San Francisco, California, May 21, 1911 (J. A. Kusche); 2 females, Sacramento, California, June 26,

1938, June 28, 1938; 1 female, San Luis Obispo, California, June, 1938 (I. McCracken), on *Clarkia;* 1 female, San Luis Obispo County, California, June 3, 1938 (I. McCracken), on *Layia;* 7 males, mouth of Redwood Creek, Humboldt County, July 11, 1937 (E. C. Van Dyke); 6 males, 1 female, Orick, Humboldt County, California, July 9, 1938 (E. C. Van Dyke).

The holotype is in the Snow Entomological Collections of the University of Kansas.

### *Colletes rufocinctus* Cockerell

(Fig. 17)

*Colletes rufocinctus* Cockerell, 1929, Ann. Mag. Nat. Hist., ser. 10, vol. 4, p. 298; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 394; 1951, Wasmann J. Biol., vol. 9, p. 207.
*Colletes truncatus* Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 396.

On the basis of collected material the species appears to be most common in the northern great plains, centering in North Dakota. A few specimens have been recorded from Minnesota, Manitoba, and South Dakota, while single specimens from localities in Alberta, Colorado, and Arizona indicate that the species is scattered more sparingly along the western edge of the Great Plains as well as in the mountains of the southwest. The late fall flight period may have some effect on the incomplete collections.

Both sexes have a rather characteristic feature in the shape of the prothoracic spines, which have a modified truncate appearance; the posterior edge is rounded while the anterior margin is weakly pointed, terminating in a sharp, short spine protruding laterally beyond the posterior margin. The males closely resemble *fulgidus* except in the somewhat shorter malar spaces, the peculiarity of the prothoracic spines, and the absence of the laterobasal projection of the seventh ventral plates. The females differ in the prothoracic spines and in the more distinct puncturation of the first metasomal tergum.

*Male:* length 9.5 mm., wing length 6 mm.

Pile of face white and concentrated principally over clypeus and lower antennal bases; vertex with very sparse, pale grey pile; upper genal areas with pile pale grey to white, becoming much longer, finer, and whiter below; mesoscutum with pile pale grey, long, fine and erect; scutellum with a dense peripheral margin of long, fine, pale grey pile; mesepisterna with pile long, fine, and erect, not concealing surface; propodeum with a weak fringe of pale grey pile along lateroposterior margin, not extending directly to pedicel,

lateral and posterior faces with scattered, shorter, pale grey pile; pile of legs short, sparse, and pale grey; first metasomal tergum with a broad fascia of whitish to greyish pubescence, fascia sometimes interrupted medially due to wearing, lateral fringes of white pile extending to apical fascia, discal area with abundant, erect, pale grey pile, not at all concealing the surface; metasomal terga two to five with broad, rather dense fasciae of white pile, broadened slightly at extreme lateral margins; metasomal terga three to six having discs with sparse, short, erect, pale grey to fulvous pile, not at all concealing surface; metasomal sterna with apical fringes of short, white pile, complete but slightly shorter medially.

Antennae long, deep brown to black, flagellar segments one and one-fourth times as long as broad; malar spaces three-fourths as long as broad; clypeus convex with a very shallow, longitudinal median sulcus, sulcal area very closely and finely punctate to apex, punctures over basal third close and dense as in sulcal area, latero-apical portions shiny, sparsely punctate to impunctate; vertex dull, closely and densely punctate. Prothoracic spines obliquely truncate with the anterior margin pointed sharply and protruding beyond posterior; mesoscutum coarsely and densely punctate over anterior one-third, punctures becoming much sparser on disc, impunctate area large; scutellum coarsely and rather sparsely punctate over disc, punctures becoming sparser anteriorly, anterior one third shiny, impunctate, a weak median longitudinal sulcus extending to anterior margin; mesepisterna densely punctate, punctures no more than one-half puncture width apart, closer on dorsal face; propodeum shallowly, almost obscurely, pitted with quadrate pits, lateral and posterior faces dull and roughened; tegulae brownish hyaline; wings dusky with abundant, light ochreous pubescence, nervures brown; legs reddish brown to deep brown; posterior basitarsi four and three-fourths times as long as broad. First metasomal tergum densely punctate with coarse punctures, punctures no more than one puncture width apart; second metasomal tergum punctured much as first, only having punctures slightly smaller, tergum distinctly depressed basally; metasomal tergum three finely punctate or coarsely folliculated; metasomal sterna shiny, very finely folliculated on apical margins; seventh ventral plates resembling those of *fulgidus,* however lacking lateral projection to basal portion of each plate (fig. 17).

*Female:* length 10.5 mm., wing length 7.5 mm.

Pile of face sparse, erect, and clumped principally laterad of

antennal bases along inner orbital margins, pile pale grey; vertex with light ochreus pile principally in ocellar region; upper genal areas with abundant, short, light ochreus pile, pile becoming longer and whiter below with a very narrow margin of short, appressed pile immediately posterior to each compound eye; mesoscutum with pile tinged with light ochreus about anterior one-fourth and lateral margins, discal area having abundant, black pile; scutellum with a peripheral rim of light ochreus pile, discal area with abundant, black pile; mesepisterna with pile long, fine, and weakly tinged with yellow; propodeum with long fringes of pale grey to light ochreus pile along lateroposterior margins extending down to pedicel, lateral and posterior faces with scattered, short, erect, pale grey pile; pile of legs pale grey except on posterior femora where it is tinged with light ochreus; first metasomal tergum with apical fascia very narrow and weak, interrupted medially, lateral fringes of pale pile extending half way to apical fascia, usually not complete, discal area with very few, erect, light grey hairs; metasomal terga two to five with fasciae broad and weak, composed of very fine, short, white pile; second metasomal tergum with a basal fascia equal in width and density to apical fascia; metasomal sterna two and three with weak lateral fringes of pale grey pile.

Antennae brown, flagellar segments as long as wide; malar spaces one-third as long as broad; clypeus convex, weakly depressed medially at mediolongitudinal line, surface shiny, coarsely, striately punctate; vertex shiny and sparsely punctate, fascial foveae narrow, extending just above inner orbital margins of compound eyes, and extending barely more than one-fourth of way to lateral ocelli. Prothoracic spines obliquely truncate with anterior margin pointed and extending beyond posterior margin; mesoscutum densely punctate with punctures of variable size, almost contiguous in spots and separated by one to two puncture widths in others, impunctate area small; scutellum with punctures of variable size, punctures one to two puncture widths apart, anterior face shiny, impunctate; mesepisterna dull, very densely, contiguously punctate, almost roughened; propodeum quadrately pitted with shiny pits, lateral and posterior faces transversed by very weak rugae; tegulae brownish hyaline; wings dusky, nervures brown; legs reddish brown to deep brown; posterior basitarsi four times as long as broad. First metasomal tergum finely, obscurely punctate, punctures approximately one to two puncture widths apart on lateral faces, becoming shallow and more obscure medially, surface shiny; second metasomal tergum shiny, impunctate; metasomal sterna shiny, very finely folliculated

over posterior one-half of each sternum. Precoxal spines twice as long as broad.

*Distribution:* Manitoba: Magnus. Alberta: Lethbridge; Medicine Hat. Minnesota: Barrett; Barry; Detroit, Polk County. North Dakota: Beach; Burgan; Crary; Devil's Lake; Dickinson; Edgeley; Fargo; Jamestown; Lakota; Mandan; Martin; Minot; McKenzie; Monango; Mott; Schafer; Sentinel Butte; Steele; Williston. South Dakota: Platte; White River, Stanley County. Wyoming: Sheridan. Colorado: Chimney Gulch. Arizona: Flagstaff; Huachuca Mountains.

*Flight records:* The species flies from August 3 to September 15.

*Plant records: Aster paniculatus, Grindelia squarrosa, Helianthus petiolaris, Melilotus alba, Solidago canadensis, Solidago rigida, Taraxacum.*

The holotype of *rufocinctus* from between Long's Peak Inn and Estes Park, Colorado, is in the collections of the Citrus Experiment Station, Riverside, California, and that of *truncatus* from Estes Park, Colorado, is in the American Museum of Natural History.

### *Colletes louisae* Cockerell

(Fig. 18)

*Colletes louisae* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 46; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 24; 1898, Bull. Denison Univ., vol. 11, p. 43; 1898, Bull. Univ. New Mexico, vol. 1, p. 43; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292.

*Colletes tucsonensis* Cockerell, 1906, Canadian Ent., vol. 38, p. 163; 1935, Pan-Pac. Ent., vol. 11, p. 54; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 402 (new synonymy).

*Colletes texanus,* Cockerell (not Cresson), 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 24; 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 45; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292 (these references placed under *tucsonensis* by Timberlake, 1943).

An examination of the type of this species proves it to be the same as the better known *tucsonensis.* The species is rather distinctive on the basis of the seventh ventral plates in the male, and by the strong scutel admixture of black pile accompanied by the shiny, impunctate first tergum in the female. The males have the pile of the mesoscutum and the scutellum entirely pale grey except for a few specimens from California where there appears to be a weak admixture of dark hairs, particularly about the posterior face of the scutellum. Slight variation exists in the puncturation of the first metasomal tergum, with punctures very fine, becoming denser on the extreme lateral margins. The females closely resemble those

of *birkmanni,* differing in having a very strong admixture of black pile on the mesoscutum and scutellum.

*Male:* length 9.5 mm., wing length 7 mm.

Pile of face long, dense, and pure white, extending well above antennal bases; pile of vertex and upper genal areas pale grey, dense, and erect, becoming longer and whiter on lower surfaces of occiput; mesoscutum and scutellum with pile pale grey, long, erect, and plumose; mesepisterna with pile long, fine, and white; dense fringes of white pile along lateroposterior margins of propodeum, extending halfway down to pedicel, lateral and posterior faces with sparse, erect, white pile; pile of legs short, sparse, and white; first metasomal tergum with fascia broad, dense, and pure white, lateral fringes of pile very long and dense, extending to apical fascia, discal area with abundant, long, fine, white pile, not at all concealing surface; fasciae of metasomal terga two to five dense, broadened at extreme lateral margins, and pure white; metasomal terga three to six with short, pale grey, erect pubescence, not at all concealing surface; metasomal sterna two to five with long, dense fringes of white pile from apical margin.

Antennae brownish black, flagellar segments one and one-half times as long as broad; malar spaces as long as broad; clypeus finely and densely punctate over basal two thirds, punctures very weakly rugose, extending down a median longitudinal line almost to apex, extreme apex and lateral apical margins of clypeus shiny, impunctate; vertex dull, closely and densely punctate; mesoscutum densely punctate over anterior one half, impunctate area large; scutellum densely punctate over posterior one half, punctures becoming much sparser and almost absent on anterior half, a weak longitudinal median sulcus extending to anterior margin; mesepisterna densely punctate, punctures slightly larger than those of mesoscutum, interspaces shiny below; propodeum with basal area shallowly, quadrately pitted, lateral and posterior faces dull, transversed by many weak rugae; tegulae light hyaline brown; wings whitish hyaline with very sparse, short, whitish pubescence apically, nervures brown; legs deep reddish brown basally, lighter brown apically; posterior basitarsi four times as long as broad. First metasomal tergum very finely and shallowly punctate, punctures two to three puncture widths apart laterally, becoming sparser, almost folliculated, medially; second metasomal tergum coarsely folliculated or finely punctate, punctures dense, no more than one puncture width apart, interspaces shiny; metasomal sterna shiny, coarsely and

sparsely folliculated over posterolateral margins of each segment; seventh ventral plates much as in *eulophi,* however with a dense clump of long pile arising from lateral aspects of the neck of each plate (fig. 18).

*Female:* length 11 mm., wing length 7.5 mm.

Pile of face long, white, and erect, concentrated principally about upper antennal bases with a few long, white hairs overhanging clypeus, not concealing surface; pile of vertex dusky grey with a few dairk hairs intermixed; pile of genal areas short, pale grey, becoming much longer and finer below; mesoscutum with pile white to pale grey about extreme anterior and lateral margins, abundant black pile intermixed on discal area; scutellum with a peripheral rim of pale grey pile, having much black hair mesad to peripheral pale grey; mesepisterna with abundant, long, white pile, partially concealing surface; propodeum with dense, long fringes of whitish pile on upper lateroposterior margins, lateral and posterior faces with scattered, erect, white to pale grey pile; legs with pile long, plumose, and white to weakly tinged with ochreus, particularly on posterior femora and tibiae; first metasomal tergum with a dense fascia of pale grey pile, lateral fringes long and white, extending to apical fascia, a few erect, scattered hairs over discal surface; second metasomal tergum with a distinct basal fascia of white pile, fascia weak but complete; metasomal terga two to five with broad apical fasciae of white pubescence; metasomal terga three to six with discal area having abundant, erect, pale grey to black pile, not concealing surface; metasomal sterna two to five with weak fringes of long, pale grey pile interrupted medially.

Antennae deep brownish black, flagellar segments about as long as wide; malar spaces one-third as long as broad; clypeus weakly convex with a very faint, median longitudinal sulcus, surface coarsely, striately punctate with shiny ridges; vertex shiny with a few shallow, scattered punctures. Prothoracic spines long, protruding to edge of head; mesoscutum rather densely and coarsely punctate on lateral and anterior faces, punctures varying from contiguous to two puncture widths apart; scutellum coarsely and sparsely punctate over discal area, punctures from contiguous to two puncture widths apart, anterior one fourth shiny, impunctate, a weak longitudinal median sulcus extending to anterior margin, mesepisterna very densely, contiguously punctate, dull; propodeum with basal area shallowly, quadrately pitted, lateral and posterior faces dull, weakly rugose; tegulae brownish hyaline; wings tending to

whitish hyaline with a little, short, scattered, light ochreus pubescence apically; legs brown; posterior basitarsi four times as long as broad. First metasomal tergum shiny with a few, very shallow follicles over surface; second metasomal tergum shiny, impunctate; metasomal sterna shiny, finely folliculated on lateroapical extremities.

*Distribution:* The species occurs in abundance throughout southern California with marginal localities at: Death Valley; Lone Pine, Inyo County; Palmdale, Los Angeles County; San Bernardino; San Felipe Creek, San Diego County; Imperial County; and Blythe. It has also been recorded from the following southwestern states: Nevada: Austin; Kyle Canyon, Charleston Mountains; Lee Canyon. Arizona: Ajo; San Pedro River, Fairbanks; Santa Rita Mountains; Tucson. New Mexico: Tucumcari. Texas: El Paso; Hot Springs, Big Bend Park.

*Flight records:* The species seems to have two generations per year, the first flying from March 17 until June 7. The records of the fall generation are August 10 to November 26. Both of these records are Californian.

*Plant records: Baccharis, Chrysothamnus nauseosus, Isocoma veneta* var. *acradenia, Larrea tridentata* var. *glutinosa, Melilotus, Prosopis juliflora, Solidago.*

The holotype of *louisae* from New Mexico is in the United States National Museum, and that of *tucsonensis* from Tucson, Arizona, is in the collections of the Citrus Experiment Station, Riverside, California.

### *Colletes bryanti* Timberlake

(Fig. 19)

*Colletes bryanti* Timberlake, 1951, Wasmann J. Biol., vol. 9, pp. 208-10.

This species is most closely related to the *slevini-kincaidii-eulophi* portion of the *simulans* group. The male closely resembles that of *slevini,* differing in having the punctures of the mesopleura coarse and almost contiguous over the upper portion. While most specimens of this sex have a weak admixture of dark pile on the mesoscutum, a few do not. In these seemingly aberrant forms the scutum and scutellum is tawny to almost white rather than the typical light ochreus. The seventh ventral plates closely resemble those of *slevini* in general form but have the dorsal fringes of the pile extending almost to the basal articulatory condyles along their entire width. The female resembles the females of *kincaidii, eulophi,*

and *slevini.* Where the four occur together, as in the Oak Creek area of Arizona, they are difficult to separate. The female of *bryanti,* however, has the mesopleura coarsely and densely, almost contiguously punctate over the upper surfaces while the others have the punctures well separated by shiny impunctate areas. The females of *bryanti* also have the fascial foveae deeply depressed and impunctate, extending beyond the compound eyes to the lateral ocelli; the vertex is deeply and closely punctate; the pile of the mesoscutum and scutellum is deep ochreus. However, specimens of the three closest relatives often tend to display similar variations and distributional data are based on males alone.

*Male:* length 9.5 mm., wing length 6.5 mm.

Pile of face long, dense, and lightly tinged with yellow; pile of vertex erect, light ochreus, clumped principally in ocellar triangle and about upper surfaces of genal areas, pile becoming much longer, finer, and almost pure white on lower surfaces; mesoscutum and scutellum with abundant, dense, ochreus pile, not concealing surface, a moderately strong admixture of very deep testaceous or deep ochreus pile intermixed with this ochreus pubescence, tending to give it appearance of being intermixed with black hairs; pile of mesepisterna long, fine, plumose, and pale grey; propodeum with dense fringes of long, pale grey pile on upper lateroposterior faces, posterior face with a weak covering of fine, erect pile; legs with pile sparse and pure white to pale grey; metasomal terga with weak fasciae on terga one to five, fasciae becoming progressively broader and whiter towards apical metasomal terga; first metasomal tergum with fascia very narrow and almost removed medially, pile very lightly tinged with yellow, a lateral fringe of pale grey pile extending to apical fascia, discal area with abundant, erect, fine, pale grey pile, not at all concealing surface; metasomal terga four to seven with abundant, short, erect, black pile, not at all concealing the surface; sternal fasciae weak, continuous only on sterna two and three, on metasomal sterna four and five fasciae represented by lateral tufts of long pile.

Antennae long, deep brown, flagellar segments approximately one and one-half times as long as broad; malar spaces as long as broad; clypeus convex with evidence of a weak longitudinal median sulcus, and extending down to apical portions of clypeus, surface densely, striately punctate along medioapical portions of surface, apical one third shiny and rather sparsely punctate; vertex very coarsely and densely punctate, dull. Prothoracic spines absent; mesoscutum

coarsely and densely punctate over entire surface, punctate area very small; scutellum closely punctate over posterior three-fourths of surface, punctures not at all striate; mesepisterna densely punctate with rather coarse punctures tending to be somewhat striated on upper half of surface; propodeum with basal area very shallowly or obscurely pitted, pits not at all quadrate, basal area transversed by irregular, weak rugae extending to posterior margin, posterior and lateral faces dull, weakly rugose; tegulae brown; wings dusky with abundant, short, fulvous pubescence principally on apical one-third; legs black; posterior basitarsi three and one-half times as long as broad. Metasomal terga depressed apically to contain apical fasciae, apical depressions most evident on lateral portions of each segment; first metasomal tergum densely and rather coarsely punctate, punctures approximately one to two puncture widths apart; second metasomal tergum punctured much as first, only with punctures denser, no more than one puncture width apart, basal portion of second metasomal tergum abruptly depressed; metasomal sterna shiny, coarsely and sparsely folliculated; seventh ventral plates elongate, much as in *slevini*, but with the basal hair band of *bryanti* extending well up under the basal articulatory condyle, medio-apical margin of plates narrowed slightly not broadly rounded as in *slevini* or *kincaidii* (fig. 19).

*Female:* length 9 mm., wing length 7 mm.

Pile of face long, dense, and pale grey, particularly about antennal bases; vertex with a few scattered, light ochreus hairs; pile of upper genal areas light ochreus, tending to become longer and whiter below; mesoscutum and scutellum with pile ochreus intermixed with a few, deep ochreus or testaceous hairs; mesepisterna with pile long, fine, and pale grey; pile of legs rather short and light ochreus to pale grey except on posterior pair, where tibiae have abundant, short, black hairs over entire upper surface; metasomal terga with fasciae white, rather weak and narrow; first metasomal tergum with a very weak lateral fringe of pale grey pile extending to apical fascia, surface with a very sparse covering of long, pale grey pile; metasomal terga four to six with discal area having abundant, erect, long, testaceous to black pile, a very faint basal fascia to second metasomal tergum, most evident towards lateral margins; metasomal sterna nonfasciate except for a few longer, grey hairs on apical half of each segment.

Antennae long, deep brown, flagellar segments approximately three-fourths as long as broad; malar spaces one-half as long as

broad; clypeus weakly convex, rather coarsely, striately punctate to the apex, median longitudinal area of clypeus with punctures finer and denser, reminiscent of a weak sulcus; vertex very coarsely and densely punctate, dull; fascial foveae depressed deeply and of uniform width extending up towards top of compound eye, not reaching more than one third of way to lateral ocelli. Prothoracic spines absent; mesoscutum rather coarsely and densely punctate, impunctate area small; scutellum coarsely, nonstriately punctate over posterior two thirds, anterior one third shiny and relatively free of punctures; mesepisterna closely and coarsely punctate, punctures almost contiguous over surface, tending slightly towards rugosity at extreme upper posterior portion of face; propodeum with basal area shallowly pitted with quadrate pits, lateral and posterior faces dull and transversed by many weak rugae; tegulae deep brown; wings dusky with abundant, deep fulvous pubescence, nervures deep brown; legs brownish black to black; posterior basitarsi three times as long as broad. First metasomal tergum closely and densely punctate, with punctures varying from one to two puncture widths apart; second metasomal tergum much more closely and finely punctate with punctures usually not exceeding one puncture width apart, particularly on anterior median portions of disc, punctures becoming much sparser laterally; metasomal terga one to four with apical fascial areas depressed, particularly evident on lateral faces; metasomal sterna coarsely but sparsely punctate, much as in *eulophi*, interspaces shiny.

*Distribution:* Arizona: Santa Rita Mountains, September 15, 1933, October 5, 1936 (Bryant) (paratypes); Graham Mountain, September 5, 1937, September 25, 1937, September 8, 1937 (Bryant) (paratypes); Onion Flat, Chiricahua Mountains, August 12, 1940 (E. S. Ross) (paratype); Tucson, April 15, 1933 (Bryant) (paratype); Santa Rita Mountains, May 9, 1937 (W. Benedict); Alpine, June 4, 1937 (Grace and John L. Sperry); Dawson Camp, Salt River, September 7 (C. H. T. Townsend); Greer, June 2, 1946 (R. M. Bohart); Oak Creek Canyon, August, 1947 (R. M. Bohart); Sabino Basin, Santa Catalina Mountains, October 3 (C. H. T. Townsend). New Mexico: Cloudcroft, June 27, 1940 (L. J. Lipovsky); Tajique, June 25, 1940 (E. E. Kenaga).

The holotype from the Santa Rita Mountains, Arizona, is in the collections of the California Academy of Sciences.

## *Colletes birkmanni* Swenk

(Fig. 20)

*Colletes birkmanni* Swenk, 1906, Ent. News, vol. 17, p. 259.

The species is restricted to the southern portion of the Great Plains with males taken from Texas to western Kansas. It is quite possible that it may be replaced by the closely related *slevini* in the foothills of the mountains and in the more northerly latitudes. A Swenk metatype from Nebraska City, Nebraska, must be the female of *slevini* although the determination of a single female is difficult. The males closely resemble those of *slevini* externally except for having the punctures of the first metasomal tergum finer and sparser and in having the pile of the mesoscutum all light ochreus to tawny grey. There are minor differences in the seventh ventral plates, as illustrated. In the capsule the gonostyli of *birkmanni* are not nearly the length of the terminal portions of the gonocoxites while the gonostyli of *slevini* are at least as long as the terminal portions of the gonocoxites. The males exhibit slight variation in the color of the pile of the mesoscutum, which varies from pale grey to light ochreus; punctures of the first metasomal tergum are also rather variable in density and coarseness, but are at least two puncture widths apart on the lateral surfaces. The females closely resemble those of *slevini* but can be distinguished in having the pile of the terga five and six light golden to ochreus rather than the deep fuscous to black of *slevini;* the fifth and sixth metasomal sterna of *birkmanni* are much more coarsely and densely punctate than are those of *slevini.* There are some variations in the pile color of the mesoscutum and the scutellum, which varies from a light golden to ochreus regardless of locality. Similarly, the shape of the prothoracic spines varies from roughly triangular to sharply pointed; however, the length is consistently slightly longer than the width across the base.

*Male:* length 9 mm., wing length 7.5 mm.

Pile of face dense and pure white, reaching well above antennal bases; vertex and upper genal areas covered with light ochreus, erect pile, pile of lower genal areas becoming much longer, denser, and pure white with a weak rim of appressed shorter pubescence immediately posterior to compound eyes; mesoscutum with pile dense, long, and tinged with light ochreus; scutellum covered similarly to mesoscutum; mesepisterna covered with dense, long, fine, white pile, weakly plumose; propodeum with dense fringes along the upper margins of lateroposterior faces, posterior and

lateral faces with a sparse covering of erect, fine, pale grey pile; pile of legs fine, white, and sparse; first metasomal tergum with a fascia of long, white pile, lateral fringes of white pile reaching to apical fascia, discal area with abundant, erect, pale grey pile, not at all concealing the surface; fasciae of metasomal terga two to five broad, dense, and almost pure white; discal areas of metasomal terga two to six having erect pile pale grey to a very light ochreus, not at all black; metasomal sterna with apical fasciae of dense, short, white to pale grey pile, very weakly broadened medially, fasciae of sterna three to five having lateral tufts of longer, more plumose hairs.

Antennae long, deep brown, flagellar segments one and one-half times as long as broad; malar spaces seven-eighths as long as broad; clypeus weakly convex, densely and finely punctate over basal one-half, punctures on apical half larger and tending to be striate except for the extreme apex which is shiny impunctate; vertex shiny and finely punctate with shiny interspaces. Prothoracic spines short and sharp, roughly triangular; mesoscutum finely and densely punctate, impunctate area large; scutellum rather densely punctate over posterior one-half, punctures a similar size to those of the mesoscutum; mesepisterna with punctures similar in size to those of mesoscutum and approximately one-half to one puncture width apart, with interspaces shiny, not at all rugose; propodeum with basal area shallowly pitted with elongate, quadrate pits, lateral and posterior faces dull and roughened; tegulae brownish hyaline, wings dusky with a sparse covering of light ochreus pubescence, particularly on apical one-third, nervures brown; legs black; posterior basitarsi four and one-fourth times as long as broad. First metasomal tergum shiny and sparsely punctate, punctures approximately two to four puncture widths apart and fine; second metasomal tergum with punctures much closer, varying in density from one to three puncture widths apart, interspaces shiny; apical margins of terga one to four depressed, depression decidedly distinct laterally and evident across breadth of each segment; metasomal sterna shiny with a few coarse follicles, particularly on extreme apical portions of each sternum; seventh ventral plates much as in *slevini*, but slightly longer and with a broad, dense hair band circumventing periphery of basal half of each plate; gonostyli of capsule not nearly length of terminal portion of gonocoxites (fig. 20).

*Female:* length 11 mm., wing length 8 mm.

Pile of face white, erect, and concentrated principally about antennal bases; pile of genal areas tinged with yellow above becoming longer and whiter below; mesoscutum and scutellum with pile dense, erect, and weakly tinged with light yellow; mesepisterna with pile long, fine, and white; propodeum with fringes of long, pale grey pile along lateroposterior margins, posterior face sparsely covered with erect, pale grey pile; pile of legs long, rather dense, tinged with light ochreus; first metasomal tergum with a weak apical fascia easily removed by rubbing, fascia white, tergum with lateral fringes of white pile extending to apical fascia, discal area, particularly anterior face, with sparse, erect, pale grey hairs; metasomal terga two to six with broad apical fasciae of pure white pile, fasciae often removed medially due to some abrasion; second metasomal tergum with a weak basal fascia of pure white pile; discal areas of metasomal terga four to six with pile pale grey to very light ochreus, never black; metasomal sterna with a few scattered, erect hairs.

Antennae brown, flagellar segments three-fourths as long as broad; malar spaces three-eighths as long as broad; clypeus weakly convex, rather coarsely and sparsely striately punctate, punctures becoming sparser towards apex, median longitudinal line very weakly depressed to form a weak sulcus; vertex shiny with a few sparse, fine punctures; fascial foveae narrow, indistinct, barely reaching to the upper edge of the compound eye. Prothoracic spines strong and roughly triangular, just slightly longer than width across base; mesoscutum densely punctate about anterior one-half and lateral margins, impunctate area large; scutellum densely almost rugosely punctate on posterior one fourth, punctures becoming sparser with shiny interspaces over discal area and virtually impunctate on anterior one fourth; mesepisterna coarsely punctate, punctures almost contiguous; propodeum with basal area shallowly pitted with elongate, quadrate pits, lateral faces shiny transversed by a few, very weak rugae, posterior face dull and roughened; tegulae very light hyaline brown; wings dusky to whitish hyaline with abundant, very pale pubescence on the apical one third, nervures light brown; legs reddish brown; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, very sparsely and weakly punctate, punctures three to five puncture widths apart, apical fascial margins of terga one to five depressed slightly and brownish hyaline rather than black of discal areas; metasomal sterna very coarsely and densely folliculated, interspaces shiny.

*Distribution:* Texas: Fedor; Lee County; Dallas; Victoria; College Station; Davis Mountains; Terrell; Colorado County; Brownwood; Albany; Del Rio; Austin; Langtry; Southmost, Cameron County; Eldorado; Roundrock. Oklahoma: Rush Springs. Kansas: Meade County State Park; Hamilton County. New Mexico: Desmoines.

*Flight records:* In Texas the species appears to have two generations, the first generation flying from March 27 to June 12 and the second flying in November. A number of specimens labelled merely November are from Lee County, Texas, and a single specimen taken at Austin is labelled November 11. In Kansas and Oklahoma the species appears from April 9 to June 7, and the single New Mexico male is dated June 18.

*Plant records: Rhus microphylla.*

The holotype from Fedor, Texas, is in the collections of the University of Nebraska.

### *Colletes slevini* Cockerell

(Fig. 21)

*Colletes slevini* Cockerell, 1925, Proc. California Acad. Sci., ser. 4, vol. 14, p. 185.
*Colletes sleveni*, Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 208.
*Colletes eriogoni* Cockerell, 1939, Pan-Pacific Ent., vol. 15, p. 188; 1939, Proc. California Acad. Sci., ser. 4, vol. 23, p. 429; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 392.

The females can be distinguished with slight difficulty from *birkmanni* as described above but are at times difficult to tell from *bryanti* except by locality data and sex association. *C. slevini* is found principally in California but does extend northward to Oregon, thence east and north to Utah, Nevada, and Colorado, whereas *bryanti* has only been recorded with certainty from more southern parts of Arizona and New Mexico. The males can be accurately distinguished from *birkmanni* and *bryanti* on the basis of genitalic examination, for in *bryanti* the anterior lateral fringe of hair on the seventh ventral plate reaches to the basal articulatory condyle along the basal area from median to lateral margins. In *slevini* this fringe extends mediobasally from a point one third of the way down the median margin but never reaches the basal condyle at its greatest basal penetration. The males exhibit a great deal of variation in the color of the pile of the mesoscutum and scutellum, grading from the more typical deep ochreus to a light grey. Similar variation occurs in the coarseness and density of the puncturation of the first metasomal tergum. In most specimens the punctures are very fine

and at least one to two puncture widths apart, while in others the punctures become coarser and denser, particularly laterally where they are not usually more than one puncture width apart. The malar spaces fluctuate from seven-eighths to as long as wide. The prothoracic spines are short and sharp, tending to be somewhat needlelike rather than triangular. In the females the pile of the mesoscutum and scutellum is more uniformly deep ochreus, although in a few there is some degree of greyness evident. There is a similar variation in the puncturation of the first metasomal tergum; the typical and most abundant specimens are very finely and shallowly punctate with punctures one to two puncture widths apart; however isolated specimens have the first tergum closely punctate laterally with rather coarse punctures approximately one puncture width apart, these punctures become much sparser medially to resemble the more typical form.

*Male:* length 9 mm., wing length 6.75 mm.

Pile of face long, dense, and light ochreus, completely concealing clypeus and basal areas of antennae; vertex with pile long, rather dense, and deep ochreus; pile of upper genal areas ochreus, becoming much longer and more pale grey below; mesoscutum and scutellum with pile tinged with ochreus, long, erect, and dense; mesepisterna with pile very light ochreus above, tending to pale grey below, pile long, fine, and rather sparse; propodeum with dense lateroposterior fringes of light ochreus pile extending down towards pedicel, lateral and posterior faces with abundant, erect, shorter, pale grey to light ochreus pile; legs with pile fine, moderately dense, and just tinged with ochreus; first metasomal tergum with fascia dense, broad, and weakly tinged with yellow, lateral fringes of long, ochreus pile extending to fascia, disc with abundant, erect, light ochreus pile not concealing surface; metasomal terga two to five with fasciae broad, dense, and tinged with light yellow, particularly evident about basal portion of each fascia; metasomal terga three to six having discs with abundant, short, deep testaceous to black, erect pile, not concealing surface; metasomal sterna with fasciae evident as long lateral fringes of pile, absent medially.

Antennae deep brown and long, flagellar segments approximately one and one-half times as long as broad; malar spaces as long as broad; clypeus weakly convex, finely and densely punctate over basal one half and down a median longitudinal line towards apex, apex and lateroapical portions sparsely punctate and shiny; vertex dull, densely and deeply punctate. Prothoracic spines sharp,

scarcely longer than width across base; mesoscutum densely and closely punctate, impunctate area small, almost absent; scutellum very densely and closely punctate over posterior two thirds of surface, anterior one third shiny, impunctate; mesepisterna deeply and densely punctate with narrow, shiny interspaces, punctures equal in coarseness to those of mesoscutum; propodeum with basal area shallowly, irregularly pitted, pits not uniformly quadrate; propodeum with lateral and posterior faces dull and roughened; tegulae brownish hyaline; wings dusky with a sparse covering of light ochreus pubescence, nervures brown; legs deep reddish brown; posterior basitarsi four times as long as broad. First metasomal tergum shiny, irregularly punctate, punctures not uniformly round, some triangular, some roughly hexagonal, and some close to being round; punctures on lateral faces approximately one puncture width apart, becoming sparser and much finer medially, fascial depression of first tergum distinct across entire breadth; discal area elevated and appearing to be flattened in four or five different planes; second metasomal tergum with punctures closer than first, not more than one puncture width apart; fasciae to metasomal terga two to four in distinctly depressed apical margins, depressions most evident along median part of each segment; metasomal sterna shiny, very sparsely and finely folliculated; seventh ventral plates much as in *birkmanni* except in having densely fasciate rims extending from half way down median areas diagonally to basal lateral margins (fig. 21).

*Female:* length 10 mm., wing length 6.25 mm.

Pile of face dense and semiappressed along inner orbital margins, pile tinged with yellow and overhanging clypeus from lateral and dorsal margins; vertex with pile light ochreus; upper genal areas with pile strongly tinged with yellow, pile becoming much longer and lighter yellow below, a narrow rim of appressed yellowish pubescence immediately posterior to compound eyes; mesoscutum and scutellum with pile light ochreus, short, and dense; pile of upper mesepisterna tinged with ochreus, tending to pale grey below; propodeum with strong fringes of light ochreus pile on lateroposterior margins extending to pedicel, lateral and posterior faces with abundant, erect, yellowish pile; pile of legs long, plumose, and weakly tinged with yellow; metasomal fasciae broad, dense, and tinged with yellow; first metasomal tergum with lateral fringes of yellowish pile extending to fascia, tergum with discal area having abundant, erect, ochreus pile, not concealing surface; metasomal terga three

to six with discal area with abundant, black to deep testaceous, erect pile, not obscuring surface; metasomal sterna with weak fringes of long, plumose pile at apex of each sternum.

Antennae deep reddish brown, flagellar segments approximately as long as broad; malar spaces one-half as long as wide; clypeus sparsely and coarsely, striately punctate, with evidence of a weak median longitudinal sulcus, punctures extending to extreme apex and having ridges shiny; vertex shiny, sparsely punctate with fine punctures; fascial foveae shallow, not extending beyond top of inner margin of compound eye, broadened dorsally. Mesoscutum densely punctate over anterior one half, impunctate area large; scutellum with posterior half closely and densely punctate, not rugose, anterior half shiny, impunctate; mesepisterna with punctures close and dense, approximately one-half puncture width apart above, about one puncture width apart below, punctures about same size as those on mesoscutum; propodeum with basal area shallowly pitted with quadrate pits, lateral and posterior faces roughened and dull; tegulae brownish hyaline; wings slightly tending to duskiness with very fine, scattered, ochreus pubesence; legs reddish brown; posterior basitarsi approximately four times as long as broad. First metasomal tergum shiny, sparsely punctate, with punctures of irregular shape, not uniformly round, and approximately two to three puncture widths apart; second metasomal tergum with punctures finer and sparser; fasciae of metasomal terga one and two lying in abruptly declivous depressions, most evident laterally; metasomal sterna shiny and sparsely folliculated.

*Distribution:* The species occurs in abundance in California from San Diego northward, being found in particular abundance in the mountainous regions from 2500 to 8000 feet. Other records for the species are as follows: Oregon: Baker; Crater Lake Park; Hood River; Jackson County; Maupin; McKenzie; Parkdale; Pineville; Sisters; Suttle Lake; Yachats. Washington: Yakima. Idaho: Hansen; Hollister. Wyoming: Grand Teton National Park. Colorado: Grand Junction. Utah: Bryce Canyon; Lakepoint; Showell; Snowville; Watson. Nevada: Kyle Canyon, Charleston Mountains. Arizona: Carrizo Creek; Oak Creek Canyon; Prescott; White Mountains.

*Flight records:* The species appears to fly throughout the summer, being recorded from May 24 to September 30. It is possible that there is at least a partial second generation in California for there appears to be a bimodal curve in population abundance, the

first appearing in May and June, and the second in late August and September.

*Plant records: Amorpha fruticosa, Aster, Bigelovia, Chrysanthemum, Cirsium, Eriogonum elatum, Eriogonum fasciculatum, Eriogonum nudum, Euphorbia albimarginata, Melilotus, Nolina, Rhamnus californica.*

The holotype of *slevini* from Paraiso Springs, Monterey County, California, is in the collection of the California Academy of Sciences, that of *eriogoni,* from California, is in the Citrus Experiment Station, Riverside, California.

### *Colletes eulophi* Robertson

(Fig. 22)

*Colletes eulophi* Robertson, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 61; 1895, Trans. Amer. Ent. Soc., vol. 22, p. 116; 1904, Canadian Ent., vol. 36, p. 276; 1905, Science, vol. 23, p. 309; 1926, Psyche, vol. 33, p. 116; Graenicher, 1927, Ent. News, vol. 38, p. 233; Robertson, 1928, Flowers and Insects, p. 10; Pearson, 1933, Ecolog. Monog., vol. 3, p. 384; Brimley, 1938, Insects of North Carolina, p. 451; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 392.

*Colletes illinoiensis* Robertson, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 62; 1895, Trans. Amer. Ent. Soc., vol. 22, p. 116.

The species is very close to *kincaidii* Cockerell, being its southern sibling, and can be distinguished accurately only by an examination of the male genitalia. It has been reported from Wisconsin (Graenicher), Ontario and Quebec (Gibson and Criddle), but these records were based on specimens of *kincaidii.*

In *eulophi* the seventh ventral plates have distinct necks between the condyles and the plates while in *kincaidii* the plates have abrupt lateral shoulders, sharply emarginate beneath and becoming broader towards the apex as illustrated in the figures 22 and 23. The females are difficult, and at times impossible, to distinguish from *kincaidii* but some can be told apart upon examination of the metasomal sterna: in *eulophi* the apical halves of sterna three to five are usually coarsely though sparsely punctate while in *kincaidii* the punctures are very fine and folliclelike. This character fails in the westernly specimens. There is considerable variation in both sexes in the puncturation of the mesepisterna, mesoscutum, and first two metasomal terga; the puncturation varies in coarseness and density from one-half to one puncture width apart.

*Male:* length 9 mm., wing length 6 mm.

Face with pile long, dense, and pale grey about antennal bases, along lower inner orbital margins, and over clypeus; vertex with pile light ochreus; genal areas with upper surface having abundant,

light ochreus pile, becoming longer, finer, and pure white below; mesoscutum with pile long, dense, and ochreus; scutellum with pile light ochreus; mesepisterna with pile long and fine, ochreus above tending to pale grey below; propodeum with dorsolateral margins having weak clumps of light ochreus to grey pile, lateral and posterior faces with scattered fine hairs, not concealing surface; legs with pile short, sparse, pale grey to light ochreus; metasomal terga one to five with apical fasciae of pale grey pubescence, fasciae rather sparse; first metasomal tergum with lateral fringes of pale pile extending to apical fascia, disc and anterior face with abundant, erect, light ochreus pile; metasomal tergum two with pile short, pale grey to ochreus; metasomal terga three to six having disc with abundant, short, deep brown to black pubescence and with a few, longer, erect, light ochreus hairs on discs of five and six; metasomal tergum seven with pile light brown and appressed; metasomal sterna two and three with broad white apical fasciae, widest at mid line; metasomal sterna four and five with fasciae weak, almost absent medially.

Antennae deep reddish brown, flagellar segments one and one-half times as long as broad; malar spaces seven-eighths as long as broad; clypeus weakly convex, very finely and densely punctate over basal half, punctures becoming much sparser apically with apical one-fourth almost completely impunctate and shiny; vertex dull, finely and densely punctate. Prothoracic spines about as long as width across base, roughly triangular; mesoscutum with disc very finely and densely punctate, punctures one-half puncture width apart about anterior half and lateral margins, impunctate area large; scutellum finely, densely continguously punctate over posterior two thirds, anterior third with punctures sparser, almost impunctate on extreme anterior medial area; mesepisterna with punctures coarse and dense, no more than one puncture width apart; propodeum with lateral and posterior faces roughened, shiny, and rather coarsely striate; tegulae light brown, nervures light brown; wings with weak apical covering of light brown pubescence; legs brown; posterior basitarsi three and three-fourths times as long as broad. Metasomal terga one and two coarsely, densely punctate with punctures no more than one-half puncture width apart; metasomal tergum two with punctures slightly finer than those of first; metasomal terga three and four very finely and densely punctate with shiny interspaces; metasomal sterna shiny and weakly, sparsely folliculated or roughened.

*Female:* length 9.5 mm., wing length 7 mm.

Face with pile sparse, fine, and clumped about antennal bases, pale grey to weakly ochreus; vertex with pile light ochreus; genal areas with upper surfaces having light ochreus pile, becoming finer, longer, and much whiter below; mesoscutum with pile tinged with ochreus, very dense, and weakly plumose; scutellum with pile longer, plumose, and tinged with ochreus; mesepisterna with pile long, fine, and weakly plumose, light ochreus above to pale grey below; propodeum with dorsolateral fringes of long pale pile extending part way down to pedicel, lateral and posterior faces with a few, long, fine, white hairs; legs with pile short, sparse, and tinged with ochreus on anterior two pairs, posterior legs with abundant, long, plumose, light ochreus pile on femora and tibiae; metasomal terga one to four with fasciae of sparse, pure white pubescence, narrowest on first tergum; first metasomal tergum with lateral fringes of white pile extending to apical fascia, anterior face and disc with scattered, long, fine, white pile; metasomal tergum two with distinct white basal fascia almost as broad as apical fascia; metasomal terga four and five with abundant, erect, deep ferrugineous to black pile; metasomal tergum six with appressed, deep brown to black pile; metasomal sterna not fasciate but with scattered ochreus hairs.

Antennae brown, flagellar segments seven-eighths as long as broad; malar spaces one-half as long as broad; clypeus weakly convex, closely and densely striately punctate over basal half, punctures becoming sparser and more striate toward apex with broad shiny interspaces; vertex dull, closely and finely punctate. Prothoracic spines as long as width across base; mesoscutum densely and coarsely punctate, punctures almost contiguous over anterior half and lateral margins, large median impunctate discal area; scutellum densely, deeply, contiguously punctate over posterior seven-eighths, anterior margin shiny and sparsely punctate; mesepisterna deeply and densely punctate with punctures no more than one-half puncture width apart; propodeum with lateral and posterior faces weakly roughened, not evidently striate; tegulae brown, nervures brown; wings with sparse, weak, brownish pubescence, concentrated apically; legs brown; posterior basitarsi three and one-half times as long as broad, with weak longitudinal median excavation. Metasomal terga one and two with discs closely and densely punctate; first metasomal tergum with punctures one-half to one puncture width apart, punctures finer at extreme apical margin; second metasomal tergum with punctures finer than first; metasomal terga three and four finely punctate with shiny interspaces; metasomal

sterna three to five coarsely punctate with shiny interspaces, punctures two puncture widths apart; sterna with broad impunctate hyaline band.

*Distribution:* The species is found across the southern half of the United States and extends into the mountainous region to the west. Due to the rather disjunct collections, the entire list of localities is recorded. (Map 2.)

Arizona: Oak Creek Canyon; Grand Canyon; Flagstaff; San Francisco Mountains; Chiricahua Mountains. New Mexico: Jemez Springs; Magdelena; Bernalillo County; Springer; Tajique; Quemado; Lordsburg; Las Vegas. Utah: Bryce Canyon. Texas: Greenville. Colorado: Boulder. Kansas: Douglas County; Baldwin; Miami County; Decatur County. Missouri: Columbia; Branson; Ozark Lake. Iowa: Ames; Boone. Illinois: Carlinville. Ohio: Columbus. Kentucky: Mammoth Cave National Park. District of Columbia: Anacosta. Virginia: Richmond; Great Falls; Falls Church. West Virginia: Terra Alta. North Carolina: Linville; Bryson City; Raleigh; Cruso; Swannanoa; Black Mountain.

*Flight records:* The species flies from May 10 (Texas) to November 8 (North Carolina).

*Plant records: Aster, Ceanothus fenderli, C. americanus, Chrysanthemum leucanthemum, Clematis, Eupatorium perfoliatum, Melilotus, Solidago nemoralis, Sophia obtusa.*

The holotypes of *eulophi* and *illinoiensis* from Carlinville, Illinois, are in the Illinois Natural History Survey Collection.

Specimen number 1991, a female of *eulophi,* and number 7827, a male, are hereby designated as lectotype and lectoallotype, respectively.

### *Colletes kincaidii* Cockerell

(Fig. 23)

*Colletes kincaidii* Cockerell, 1898, Proc. Acad. Nat. Sci. Philadelphia, vol. 50, p. 52; 1898, Bull. Denison Univ., vol. 11, p. 43; 1898, Bull. Univ. New Mexico, vol. 1, p. 43; Swenk, 1904, Canadian Ent., vol. 36, p. 94; Cockerell, 1905, Psyche, vol. 12, p. 86; 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 314; 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 424; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; 1907, Univ. Colorado Studies, vol. 4, p. 240; Kenoyer, 1916, Proc. Iowa Acad. Sci., vol. 23, p. 488; Cockerell, 1919, Ent. News, vol. 30, p. 287; 1919, Canadian Ent., vol. 51, p. 271; Clements and Long, 1923, Carnegie Inst. Washington Publ., no. 336, p. 251; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 393; 1951, Wasmann J. Biol., vol. 9, p. 210.

*Colletes aestivalis,* Cockerell (not Cresson), 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 49; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 21.

*Colletes eulophi,* Gibson and Criddle (not Robertson), 1920, Rept. Ent. Soc. Ontario, p. 132; Graenicher, 1906, Bull. Wisconsin Nat. Hist. Soc., vol. 4,

p. 139; 1910, Bull. Pub. Mus. Milwaukee, vol. 1, p. 228; 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301.

*Colletes eulophi albertensis* Cockerell, 1938, Canadian Ent., vol. 70, p. 70 (new synonymy).

*Colletes sieverti* Cockerell, 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 424; 1907, Univ. Colorado Studies, vol. 4, p. 240; Clements and Long, 1923, Exp. Pollination, Carnegie Inst. Washington, Publ. no. 336, p. 251; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 393.

*Colletes stricklandi* Cockerell, 1938, Canadian Ent., vol. 70, p. 70 (new synonymy).

This species has often been confused with *eulophi* Robertson and records of the species are often erroneous. Timberlake, 1943, discusses the similarity of *kincaidii* and *eulophi* rather thoroughly and gives complete records for the distribution of *kincaidii* in the far west. The only constant difference between the two species is found in the seventh ventral plates of the male genitalia, which are shouldered laterally above, emarginate, then weakly shouldered beneath, whereas in *eulophi* the plates are uniformly constricted at the necks, expanding into fanlike apical plates. The females of the two species are virtually indistinguishable. The two can often be separated on the puncturation of the metasomal sterna which are coarsely and closely punctate in *eulophi* and shallowly punctate, almost folliculated, in most specimens of *kincaidii;* however, even this character fails in some specimens. The characters mentioned by Timberlake in his key fail when the entire range of *kincaidii* and *eulophi* is considered. It becomes essential to separate the females of the two species on their respective ranges and sex associations. There is considerable variation in the puncturation of the mesepisterna and mesoscutum and in the length of the two species. *C. kincaidii* occurs principally across the northern portion of the continent, being replaced by its sibling species *eulophi* in the south. All of the material examined from Canada and the northern states has proved to be *kincaidii.* There appears to be little overlapping of the ranges along the eastern coast where *kincaidii* predominates as far south as New York. In the western plains *kincaidii* is abundant in Colorado but a few specimens of *eulophi* have been examined from that state. Timberlake reports *kincaidii* from Beulah, New Mexico, and the author has examined a single male specimen taken in the San Francisco Mountains of Arizona on June 25, 1950. This would indicate that the species extends far to the south in the higher western mountains. There are slight differences between series from California and Washington and those taken along the eastern seaboard and the eastern provinces of Canada. There seems to be a progressive lengthening in the malar spaces in

both sexes from east to west (⅞ as long as broad to as long as broad) and in the length of the posterior basitarsi of the males (3½ to 4½ times as long as broad); also in the males the pile of the body is pale grey to light ochreus in eastern material, becoming slightly longer and much whiter on western specimens. These characters appear to be the only consistent variables in the species range. Subspecific designation would be difficult and is not deemed advisable at present. The types of *eulophi albertensis* Cockerell and *stricklandi* Cockerell, both females, examined by myself and re-examined by Dr. R. Lambert of the Division of Entomology, Ottawa, are members of the normal *kincaidii* taken from Alberta. Cockerell's contention that *e. albertensis* can be distinguished from *kincaidii* on the basis of excessively fine punctures of the first two tergites fails when a larger series is considered. The puncturation of the terga shows considerable variation in those specimens examined from Alberta. Actually the type *albertensis* does not have the "excessively fine punctures" on the first two metasomal terga, for the surfaces were covered with a dried sticky substance which obstructed detailed examination.

The type of *stricklandi* is identical with *kincaidii* as it occurs in Alberta. There is a basal fascia on the second metasomal tergum, partially concealed by the apex of tergum one and no apparent difference in the color of the stigma between *stricklandi* and *kincaidii.*

*Male:* length 10 mm., wing length 7 mm.

Face with pile long, pure white, and very dense about antennal bases, along inner orbital margins, and over clypeus; vertex with pile pale grey to light ochreus, and sparse; genal areas with pile short, erect, light ochreus above to long, fine, and pure white below; mesoscutum with pile long, pale grey, and weakly plumose, partially concealing surface; scutellum with pile very long, dense, and weakly plumose, grey to white; mesepisterna with pile long, fine, and pure white; propodeum with dorsolateral fringes of pure white pile, lateral and posterior faces with much erect white pile, not concealing surface; legs with pile white, sparse, and short; metasomal terga one to five with broad, sparse, pure white apical fasciae; first metasomal tergum with weak lateral fringes of long, white pile, anterior face and disc with abundant, long, weakly plumose, white pile; second metasomal tergum with disc having few white basal hairs, discal area with numerous, long, erect, white hairs; metasomal terga three to six with discal area covered with abundant, short,

erect, fine, deep brown to black pubescence, not concealing surface; metasomal sterna two to five with distinct apical fasciae broadened medially and narrowed laterally.

Antennae long and reddish brown, flagellar segments at least one and one-half times as long as broad; malar spaces seven-eighths as long as broad; clypeus weakly convex, closely punctate over basal half, punctures becoming coarser and more striate toward apex with broad, shiny interspaces; vertex dull, densely and coarsely punctate with punctures no more than one-half puncture width apart. Prothoracic spines about as long as broad, roughly forming an equilateral triangle; mesoscutum densely and coarsely punctate, especially over anterior and lateral margins, punctures no more than one-half puncture width apart, usually closer; scutellum closely and coarsely punctate, punctures becoming coarser and sparser towards extreme anterior margin; mesepisterna densely, distinctly punctate, punctures no more than one-half puncture width apart, with shiny interspaces; propodeum with lateral and posterior faces dull and finely striate; tegulae brown, nervures dark brown; wings dusky with abundant, fine, brownish pubescence over surface; legs deep brown to black; posterior basitarsi three and three-fourths times as long as broad. Metasomal terga one and two coarsely and densely punctate, punctures no more than one-half puncture width apart and usually much closer medially, interspaces shiny; metasomal terga three to six with punctures very fine, folliclelike, with shiny interspaces, apical fascial bands partially punctate basally and with a hyaline impunctate apical margin; metasomal sterna with discal areas dull, finely roughened, and folliculated with sparse follicles; seventh ventral plates with laterobasal shoulders, emarginate beneath each shoulder (fig. 23).

*Female:* length 11 mm., wing length 7.5 mm.

Face with pile pale grey about antennal bases, becoming shorter, sparser, and whiter along lower inner orbital margins; clypeus with very few, scattered, white, semierect hairs; vertex with pile pale grey to light ochreus; genal areas with pile light ochreus to pale grey, becoming longer, finer, and pure white below; mesoscutum with pile light ochreus, concentrated principally about lateral and anterior faces; scutellum with pile light ochreus; mesepisterna with pile long and fine, pale grey to light ochreus above to white below; propodeum with dorsolateral margins having clumps of pale grey pile, lateral and posterior faces with abundant, erect, long, pale grey pile, not concealing surface; anterior two pairs of legs with pile

white, posterior legs with pile tinged with ochreus; metasomal terga one to five with broad apical fasciae, narrowest on first tergum; fasciae one to three often tinged with light ochreus or pale grey; first metasomal tergum with distinct lateral fringes of pale grey to light ochreus pile, disc and anterior face with scattered, long, erect, white pile; metasomal terga three to five having discs with a few, scattered, long, erect, ochreus hairs; metasomal tergum six with appressed, deep brown pile; metasomal sterna with weak apical fringes of white pile.

Antennae deep brown, flagellar segments seven-eighths as long as broad; malar spaces two-thirds as long as broad; clypeus weakly convex with striate longitudinal punctures approximately one puncture width apart toward apex; vertex dull, finely and densely punctate. Prothoracic spines longer than broad, roughly forming an equilateral triangle; mesoscutum with punctures dense and coarse about anterior and lateral faces, punctures no more than one-half puncture width apart, large impunctate median area; scutellum with punctures dense and coarse, becoming sparser and slightly coarser toward anterior median area; mesepisterna with punctures fine and dense, about one-half puncture width apart, becoming sparser below where they tend to one puncture width apart; propodeum with lateral and posterior faces dull, finely striate; tegulae light brown, nervures deep brown; wings with sparse brown apical pubescence, becoming sparser basally; legs deep brown to black; posterior basitarsi about four times as long as broad, slightly broader apically. Metasomal tergum one deeply and densely punctate, punctures varying from one-half to one puncture width apart, finest and most dense along apical margin; metasomal tergum two with punctures finer and much denser than one; metasomal terga three to six with discal areas finely punctate or folliculated, shiny; metasomal sterna shiny, sparsely folliculated.

*Distribution:* The species is broadly distributed over western and northern America, being most abundant in the region west of the continental divide. Marginal localities include: San Francisco Mountains, Arizona; San Bernardino County and Yosemite, California; Nanaimo and Salmon Arm, British Columbia; Park City and Monticello, Utah; Pinecliffe, Colorado; Lethbridge, Alberta; Estevan, Saskatchewan; Russell, Manitoba; Lanorie, Quebec; Crown Point, Nova Scotia; Ithaca, New York; Delphi, Indiana; Galena, Illinois; Sioux City, Iowa; and Crete, Nebraska. (Map 2.)

*Flight records:* The species has been recorded as flying between

June 10 and September 5, with the flight peak occurring during July and August.

*Plant records: Heracleum, Medicago sativa, Melilotus, Pentstemon, Potentilla, Symphoricarpos.*

The holotype of *kincaidii* from Olympia, Washington, is in the United States National Museum, that of *sieverti* from Florissant, Colorado, is in the Citrus Experiment Station, Riverside, California, that of *eulophi albertensis* from Edmonton, Alberta, is in the Canadian National Collection, and that of *stricklandi* from Alberta is also in the Canadian National Collection.

### *Colletes delodontus* Viereck

*Colletes delodontus* Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 59; Swenk, 1904, Canadian Ent., vol. 36, p. 94; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; Cresson, 1928, Mem. Amer. Ent. Soc., no. 5, p. 59.

This and the following two species were described from females taken in the southwest. All three closely resemble and are probably members of the *kincaidii-eulophi* complex. As females of the latter are indistinguishable in that area, there is no alternative but to list the species along with their original descriptions.

"Labrum with a round dent at base in the middle with a pair of faint impressions laterally. Space between eyes and base of mandibles apparently less than half the width of the latter at base. Prothoracic spines rudimentary.

"Female length 10 mm.—Front with coarse, closely arranged punctures, on vertex they are much finer and sparse. Cheeks indistinctly punctured, shining like rest of head. Clypeus with coarse, large elongate punctures creating a longitudinal appearance. Dorsulum with deep, large punctures as closely arranged as possible on the anterior half which is dull. On the posterior half the punctures are scattered on a polished area. Scutellum punctured much as anterior half of dorsulum, sculpture of postscutellum hidden by the pubescence. Mesopleurae shining with close deep punctures. Superior disc of metathorax bounded by distinct ridge. The longitudinal divisions defined by strong ridges, the spaces longer than wide, polished. The enclosure funnel shaped with a broad neck, smooth and shining. The rest of metathorax roughened subopaque. Pubescence of face, cheeks, pleurae, legs, to the tarsi and basal segment of abdomen pale, grayish. Head and thorax dorsally rather thickly covered with a dull pubescence, tinged with ochreous. Wings clear, nervures dark brown, costal, subcostal and stigma almost black. First recurrent nervure received by the second submarginal

cell at the middle. First abdominal [tergum] with fine well separated punctures on a smooth shining surface, on the second segment the surface is the same as on the preceding, the punctures closer, the rest of the segments duller, having no distinct punctuation. Apex of abdomen with brownish hairs.

"Black. Claws very dark brown.

"Type. Coll. Acad. Nat. Sciences, Phila. Type locality, Beulah, N. M., August 25, 1899 (W. P. Cockerell). Paratype—End of August 1899 (T. D. A. Cockerell), two females. Two females, *Roripa nasturtium*, June 29, 1902 (Viereck). These specimens have the pubescence paler, whitish and appressed pubescence at bases of second and third abdominal segments. One is 8 mm. long and has the labrum dull instead of shining."

### *Colletes trigonatus* Cockerell

*Colletes trigonatus* Cockerell, 1933, Ann. Ent. Soc. America, vol. 26, p. 42; Timberlake, 1943, Bull. American Mus. Nat. Hist., vol. 81, p. 394.

This species is known only from the type. From the original description and the subsequent treatment by Timberlake there can be little doubt that it is a member of the *simulans* group, most closely related to the *kincaidii-eulophi* complex. The differences from *kincaidii* as mentioned by Timberlake are minute and similar variability can be found in individuals of *kincaidii* when a large series is examined.

However, I hesitate to synonymize this species with *kincaidii* until I have seen the type, for females of the complex are difficult to separate and, at times, indistinguishable from each other.

"Female. Length about 10 mm.; black, robust, the head and thorax with abundant long erect hair, which is very pale yellowish (without any dark hairs), white on cheeks and under side of thorax; mandibles black, flagellum very obscurely brownish beneath; face broad, orbits strongly converging below; malar space fully twice as broad as long; disc of clypeus strongly elevated, but flattened, with an irregular median channel, the whole surface very coarsely sculptured with striae and punctures; supraclypeal area presenting an elevated triangular surface, polished but grooved, its upper end acute and narrowed to a keel; third antennal joint much longer than fourth, but not as long as next two together, suture between third and fourth joints on under side deeply incised; mesothorax strongly and closely punctured, but posterior middle with a polished impunctate space; posterior truncation of metathorax with long hair; tegulae dark reddish, wings hyaline, stigma and nervures black or

nearly so, costa and subcosta both black; basal nervure not nearly reaching nervulus; second cubital cell very broad, receiving recurrent nervure slightly beyond middle; third cubital receiving second recurrent not far from end; eleven reddish hooks on hind wing; legs ordinary, anterior coxae unarmed; abdomen shining, with small but distinct punctures, hind margins of tergites very narrowly rufous; punctures of third tergite very much smaller and closer than on first; abdominal bands dense and clear white, broad and entire, on margins of tergites 2 to 4 (apparently abraded on fifth); first tergite with small white patches at sides of margin; second with a hairband at extreme base, probably often concealed.

"Colorado: Pingree Park, August 15, 1932, (Helen James). Very like *C. eulophi* Rob., the punctures of abdomen about the same, but differs by dark tegulae and stigma, and longer hair on thorax above."

The holotype is in the Citrus Experiment Station, Riverside, California.

### *Colletes utilis* Cockerell

*Colletes utilis* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 39; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 24; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292.

This species, described from a single female, closely resembles the *kincaidii-eulophi* complex and appears to me to be the female of one of the two species. It resembles *kincaidii* on the basis of the fine, sparse punctures of the metasomal sterna, but this character does not hold true over the species range of the complex.

As with other species of this group, it is harzardous or impossible to base a determination or a synonymy on a female.

"Female: Length 11 millim., anterior wing 7⅔ millim. Stoutly built, black; the rather long pubescence of face, cheeks, pleura, base of abdomen and legs greyish white or very pale grey, that of vertex and dorsum of thorax yellowish ochraceous. Face broad, with erect pale grey pubescence except on clypeus and middle of supraclypeal area, which are bare. Clypeus with elongate irregular punctures, the surface between them striate, the sculpture reminding one of the surface of a strawberry. Supraclypeal area shining, with two longitudinal rows of large subconfluent punctures on each side. Vertex very closely and distinctly punctured. Space between eyes and base of mandibles about twice as broad as long. Mandibles black, with a dark rufous ring, tips blunt, notch a fair distance from tip. Labrum with three or four short longitudinal

grooves on each side; no central pit. Antennae wholly dark, flagellum with a very fine sericeous pubescence, first joint of flagellum distinctly longer than second. Thorax quite densely pubescent above; prothoracic spine horizontal, long and slender, easily overlooked amidst the pubescence. Mesothorax moderately shiny, median groove very well marked; punctures very large and distinct, separated from each other by intervals about equal to the diameter of one. Pleura shiny with strong punctures. Enclosure at base of metathorax very short, coarsely longitudinally plicate, bounded behind by a straight transverse keel. Tegulae rufo-testaceous. Wings perfectly hyaline, nervures and stigma black. Legs entirely dark, the claws only rufescent, spurs pale brownish. Basal joints of tarsi fairly but not remarkably stout. Pubescence at tips of inner side of tarsi more or less rufous. Punctuation of first two segments strong and rather close, on a shining surface; of third extremely fine and small, on a microscopically tessellate surface. No hair-bands, but base of first segment with long hairs. Hind trochanters with a thin, long curled brush of beautifully ramose hairs.

"Hab. Las Cruces, N. M., March 23, on flowers of plum."

The holotype is in the United States National Museum.

### *Colletes wootoni* Cockerell

(Fig. 24)

*Colletes wootoni* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 42; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 24; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1901, Ent. News, vol. 12, p. 42; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 401; 1951, Wasmann J. Biol., vol. 9, p. 210.

*Colletes apacheorum* Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 401.

This is one of the most distinctive species of the *simulans* group. The male is peculiar in having very long malar spaces, approximately one and two-thirds times as long as broad, and the genitalia are unique as illustrated. The females similarly have very long malar spaces, about three-fourths as long as broad at the posterior mandibular articulations and one-half as long as broad at the anterior articulations, their apices stepped rather than uniformly sloping from posterior to anterior. The female is most likely to be confused with *slevini,* differing, however, in having longer malar spaces, short prothoracic spines, vertex finely and sparsely punctate, and fascial foveae shallow, not depressed at the dorsal ends. In the female there is a great deal of variation in the color of the

pile of the mesoscutum, from light grey to deep ochreus; this color difference occurs throughout the range of the species. The present work extends the known range of the species into southern and western Texas.

*Male:* length 9 mm., wing length 6.5 mm.

Face with pile long, dense, and pure white, partially concealing clypeus; vertex with pile long, abundant, and tawny; genal areas with upper pile white and short, becoming longer and denser below; mesoscutum with pile pale grey and dense; scutellum with pile long, pale grey, partially concealing surface; mesepisterna with pile long, fine, and white; propodeum with dorsolateral clumps of long, white pile extending down lateroposterior margins to pedicel, lateral and posterior faces with abundant, long, white hairs; legs with pile sparse, short, and white; metasomal terga one to five with weak apical fasciae of pure white pubescence; metasomal tergum one with strong lateral fringes of white pile, disc and anterior face with abundant, erect, white pile; metasomal terga two to six with discs having few, short, fine, white hairs; metasomal tergum seven with pile white to pale grey and appressed; metasomal sterna with weak apical fringe of short, white pile.

Antennae deep brown to black, flagellar segments one and one-half times as long as broad; malar spaces one and two-thirds times as long as broad; clypeus long, weakly convex with a shallow median longitudinal sulcus, punctures very fine and dense about lateral and basal areas and along sulcus, rims of sulcus shiny and sparsely punctate with few striate punctures, punctures separated by two to four puncture widths; vertex sparsely punctate with coarse punctures, interspaces shiny. Prothoracic spines very short and sharp; mesoscutum finely and densely punctate, punctures one-half to one puncture width apart, becoming much sparser posteriorly, impunctate area large; scutellum with anterior one-half sparsely punctate to impunctate shiny, punctures abundant, fine, and denser toward posterior margin where they are almost contiguous; mesepisterna with punctures fine and dense, about one-half puncture width apart; propodeum with lateral and posterior faces shiny and very finely roughened, basal area with shallow quadrate pits; tegulae brown, nervures light brown; wings whitish hyaline with scattered apical pubescence; legs black; posterior basitarsi long and slender, approximately five times as long as broad. Metasomal tergum one finely and densely punctate, punctures one to two puncture widths apart, most dense and coarse along lateral margins;

metasomal terga one to six with apical fascial margins depressed, light brown hyaline and impunctate; metasomal tergum two finely and densely punctate as tergum one but having a deep basal depression, almost as broad as apical fascial depression; metasomal tergum three finely punctate or folliculated, shiny; metasomal terga four to six shiny and weakly roughened; metasomal sterna shiny, finely roughened, apical margins hyaline; seventh ventral plates weakly pointed on medioapical margins, lateral margins of plates lobate (fig. 24).

*Female:* length 11 mm., wing length 7.5 mm.

Pile of face very long and dense about antennal margins and frontal area, clypeus overhung with a few, long white hairs from frontoclypeal suture; vertex with pile long and dense, tinged with grey; genal areas with short, white pile above, becoming longer and whiter below; mesoscutum with dense covering of light ochreus, plumose pile concealing anterior one-half and lateral margins, medial area sparsely pilose; scutellum densely and plumosely pilose about lateral and posterior margins, concealing surface; mesepisterna with pile long, fine and pure white; propodeum with dense dorsolateral clumps of long, white pile extending down posterolateral margins to pedicel, lateral and posterior faces with scattered, long, fine, erect hairs; legs with pile white to pale grey on anterior two pairs, long, dense, and plumose on posterior femora and tibiae, tinged with ochreus; metasomal terga one to four with broad, dense apical fasciae of pure white pubescence; metasomal tergum one with fascia narrowest, lateral fringes dense and white, disc and anterior face with sparse covering of long, white pile; metasomal tergum two with weak basal fascia of pure white pile; terga three to five having disc covered with short, white, erect pubescence; metasomal tergum six with pile appressed, pale grey to golden; metasomal sterna with weak apical bands of short, white, plumose hairs.

Antennae deep brown to black, flagellar segments as long as broad; malar spaces three-fourths as long as broad at posterior mandibular articulation, one-half as long as wide at anterior mandibular articulation, apical margin stepped rather than inclined from posterior to anterior face; clypeus weakly convex, deeply coarsely striately punctate with punctures one to two puncture widths apart, having broad shiny interspaces; vertex finely but sparsely punctate with shiny interspaces. Prothoracic spines short and sharp; mesoscutum with anterior half finely and densely punctate with punctures no more than one-half puncture width apart, punctures becoming

sparser and coarser posteriorly, impunctate discal area large; scutellum with anterior one-third shiny impunctate, punctures coarse and dense medially, becoming much finer and contiguous at posterior margin; mesepisterna densely and coarsely punctate with punctures one-half puncture width apart, punctures more obscure, shallower, and finer at posterior face; propodeum with lateral and posterior faces weakly roughened, tending to shiny, basal area with shallow quadrate pits; tegulae light hyaline brown, nervures deep brown; wings whitish hyaline, with sparse, short apical pubescence; legs black; posterior basitarsi four times as long as broad. Metasomal terga one and two coarsely and densely punctate, punctures no more than one puncture width apart, finer toward apical margin; metasomal tergum two with punctures slightly finer than those of first, tergum with deep broad basal depression; metasomal terga one to five with apical margins brownish hyaline and almost impunctate; metasomal terga three to five with discs sparsely and finely folliculated; metasomal sterna two to five shiny, coarsely punctate on apical one half to three fourths, extreme apical margins light brownish hyaline.

*Distribution:* The species is restricted to the southern portions of Texas, New Mexico, and Arizona. Marginal localities include: San Angelo and Big Bend National Park, Texas; Las Vegas and Las Cruces, New Mexico; Flagstaff, Chino Valley, and Nogales, Arizona.

*Flight records:* The species has been recorded as flying between March 3 and October 30. While it is possible that two generations may occur, the great preponderance of specimens fly during late June and July, which suggests that the March and October dates are aberrant extremes of the normal period of activity.

*Plant records: Amorpha fruticosa, Dasylirion wheeleri, Helenium autumnale, Helenium laciniatum, Isocoma, Melilotus alba, Nolium microcarpa, Phacelia, Petalostemon flavescens, Sapindus drummondi, Sphaeralcea laxa, Solidago occidentalis, Wislizenia refracta.*

The holotype of *wootoni* from Ruidoso Creek, New Mexico, 6400 feet, was last recorded in the Cockerell collection. I have been unable to locate this specimen. The type of *apacheorum* from Coyote Mountains, Arizona, is in the American Museum of Natural History.

## GROUP V—*aestivalis*

### *Colletes aestivalis* Patton

(Fig. 25)

*Colletes aestivalis* Patton, 1879, Proc. Boston Soc. Nat. Hist., vol. 20, p. 142; Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 116; 1904, Canadian Ent., vol. 36, p. 276; 1906, Science, vol. 23, p. 309; Viereck, 1916, Connecticut Geol. Nat. Hist. Surv. Bull., vol. 22, p. 741; Robertson, 1926, Ecology, vol. 7, p. 378; 1926, Psyche, vol. 33, p. 116; 1928, Flowers and Insects, p. 10; Brimley, 1938, Insects of North Carolina, p. 451.

*Colletes heucherae* Robertson, 1891, Trans. Ent. Soc. Amer., vol. 18, p. 61; 1895, Trans. Ent. Soc. Amer., vol. 22, p. 116.

This and the following species, *andrewsi* Cockerell, are very closely related and at times are difficult to distinguish. These are the only Nearctic members of the genus which have the inner orbital margins parallel. The males have the hind basitarsi 3.8 to four times as long as broad, and very rarely is their upper surface concealed by pile; the females have the hind basitarsi varying from four to four and one-fourth times as long as wide. Although the species was recorded from Wisconsin by Graenicher in 1935 and by Criddle *et al.* from Manitoba in 1924, an examination of the Graenicher material from Milwaukee proves the specimens to be *andrewsi* rather than *aestivalis,* and all Manitoba material examined thus far has also been *andrewsi.*

*Male:* length 12 mm., wing length 7.5 mm.

Pile of face longest and most dense about antennal bases, becoming much shorter and extremely sparse over clypeus, pile tinged with ochreus; pile of vertex and genal areas sparse and pale grey; mesoscutum with pile erect, pale grey, and moderately dense, partially concealing surface; mesoscutum and mesonotum with pile becoming longer and more dense laterally and posteriorly, forming a light ochreus to pale grey fringe about thoracic terga; mesepisterna with pile sparse, long, and weakly plumose, ochreus above tending to pale grey below; propodeum with dense lateroposterior fringes of pale grey pile, becoming weaker and shorter towards pedicel; legs with pile short and sparse, pale grey to ochreus, not completely concealing surface of tibiae or tarsi; first metasomal tergum with weak apical fascia of pure white pubescence, disc with very fine, erect, pale grey pile; metasomal terga two to six with weak, pure white apical fasciae, occasionally interrupted medially due to wear; discs of metasomal terga two to six with abundant, short, erect, black pile; metasomal sterna two to five with very dense lateroapical clumps of long, white pile, intermixed with long, pale grey

and black hairs towards lateral margins of apical sterna, no apical sternal fasciae; last metasomal sternum with abundant, short, deep brown to black pile directed posteriorly.

Antennae long and deep black, flagellar segments one and one-half times as long as broad; malar spaces one-eighth to one-fourth as long as broad; clypeus weakly convex, roughened and dull; inner orbital margins parallel; vertex dull and roughened. Prothoracic spines vestigial; mesoscutum with surface dull, shallowly folliculated; scutellum dull and roughened, more coarsely roughened to rugose posteriorly; metanotum dull and roughened; mesepisterna dull and roughened; propodeum with basal area sloping ventrally, irregularly pitted, lateral and posterior faces dull; tegulae deep brown; wings dusky, nervures brown; legs deep reddish brown becoming brown apically; posterior basitarsi very long, 3.8 times as long as broad. Metasomal terga dull and sparsely folliculated; metasoma very strongly convex beneath; seventh ventral plates large and bulbous, very densely pilose (fig. 25).

*Female:* length 12 mm., wing length 7.5 mm.

Pile of face white to pale grey, very sparse, concentrated principally about antennal bases but never concealing surface; vertex and genal areas with hair sparse, fine, and pale grey; mesoscutum with pile pale grey, most dense on anterior half; scutellum with pile dusky, longest about lateral and posterior faces; propodeum with strong lateroposterior fringes of light ochreus pile, extending down lateroposterior margins towards pedicel, posterior face with abundant, erect, pale grey pile; mesepisterna with pile very long and weakly plumose, partially concealing surface; legs with pile light grey to ochreus on posterior femora and basitarsi, pile on ventral surface of tibiae and tarsi most dense and strongly tinged with ochreus, upper surfaces not concealed; first metasomal tergum with a weak apical fascia and lateral fringe of pure white pile, discal area and anterior face weakly covered with fine, pale grey, erect pile, not concealing surface; metasomal terga two to four with broader, pure white apical fasciae; discs of metasomal terga two to six with abundant, short, erect, black pile; metasomal sterna two to five with weak, ochreus scopa, most dense on metasomal sterna two to four, few apical white hairs on lateroapical margins.

Antennae black, flagellar segments one and one-fourth times as long as broad, first flagellar segment subequal to second; malar spaces one-third as long as broad, broadest at posterior mandibular articulation; clypeus convex, roughened and not distinctly punc-

tate; vertex dull and weakly punctate. Prothoracic spines short or vestigial; mesoscutum weakly punctate about anterior and lateral surfaces, with large impunctate discal area; scutellum distinctly punctate and roughened on posterior two thirds; mesepisterna dull and roughened, not distinctly punctate; propodeum with basal area broad, irregularly and weakly pitted, lateral and posterior faces dull, roughened; tegulae deep brownish black; wings dusky, covered with very fine, brown pubescence, nervures deep brown; legs black; posterior basitarsi four times as long as broad. Metasomal terga one and two dull but distinctly punctate with shallow punctures, punctures separated by one and one-half to three puncture widths; metasomal terga three to six roughened and dull; metasomal sterna dull, densely and coarsely folliculated.

*Distribution:* Cockerell records the species as occurring in New Mexico, which is an obvious error. It is doubtful that this species ranges west of the southern portions of Illinois.

North Carolina: Raleigh; Bryson City; Cruso. Virginia: Great Falls; Skyland. New York: West Nyack. Maryland: Cabin John. Massachusetts: Pingahry Swamp. Pennsylvania: Pottstown; Cloverdale. Ohio: Summit County; Columbus. Tennessee: The Chimneys, Great Smokies National Monument. Illinois: Carlinville.

*Flight records:* May 15 to July 12.

*Plant records: Heuchera, H. americana, H. hispida.*

A female, Cabin John, Md., June 1, 1918 (R. M. Fouts), is hereby designated the neotype of *aestivalis* and is in the collections of the United States National Museum. A female, number 3996, and a male, number 7782, both from Carlinville, Illinois, are hereby designated lectotype and lectoallotype of *heucherae* and are in the Illinois Natural History Survey Collections.

### *Colletes andrewsi* Cockerell

(Fig. 26)

*Colletes andrewsi* Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 311; 1907, Univ. Colorado Studies, vol. 4, p. 239; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 385.

*Colletes aestivalis,* Criddle *et al.,* 1924, Rept. Ent. Soc. Ontario, p. 99; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301.

This species is close to *aestivalis* Patton, differing in both sexes in the length of the posterior basitarsi. The hind basitarsi of the male of *andrewsi* are about three to three and one-fourth times as long as broad and are densely plumose with the pile almost completely concealing the upper surface. In *aestivalis* the posterior

basitarsi are much longer, usually 3.8 to four times as long as broad, and are bare above. In the female the posterior basitarsi are three to 3.3 times as long as broad, while in *aestivalis* the basitarsi are four to 4.2 times as long as broad. Both sexes are much larger than in *aestivalis*, and replace *aestivalis* in the Great Plains and Rocky Mountain areas. The males of *andrewsi* are genitalically distinct, as can be seen in figure 26.

*Male:* length 14 mm., wing length 9 mm.

Face with pile short and dense, clumped principally about antennal bases, along lower inner orbital margins, and over basal half of clypeus, pale grey to ochreus; vertex with pile light ochreus to grey, becoming much longer and lighter along lower genal areas; mesoscutum with pile long, fine, and dense, tinged with deep ochreus; scutellum with pile very long and dense, strongly tinged with ochreus, being most dense on extreme lateral and posterior margins; mesepisterna with long, fine pile, dusky above, becoming light grey to whitish below; propodeum with dense clumps of long pile on lateroposterior margins, becoming sparser and finer towards pedicel, posterior face with abundant, erect, pale grey pile; legs with pile long and ochreus, most dense on posterior tibiae and basitarsi; metasomal terga one to four with narrow, pure white apical fasciae; metasomal tergum one having disc covered with fine, pale grey pile, not obscuring surface, and with strong lateral fringes of dusky pile; metasomal terga two to six with abundant, erect, black pile on discs; metasomal sterna with lateroapical margins having dense clump of long, ochreus pile forming a lateral tergosternal fringe.

Antennae long, black, flagellar segments one and one-half times as long as broad; malar spaces one-half to three-fourths as long as broad, broadest at posterior mandibular articulation; clypeus closely and shallowly punctate, almost roughened; vertex shiny with a few, scattered, fine punctures, dull medially. Prothoracic spines vestigial; mesoscutum shiny with close, shallow punctures about anterior, lateral, and posterior margins, punctures approximately one puncture width apart; scutellum shiny anteriorly, becoming progressively deeper and more densely punctate to posterior margin where the surface is weakly rugose; mesepisterna dull, finely and shallowly punctate; propodeum with basal area broad, shallowly and broadly pitted, lateral and posterior faces dull and weakly roughened; tegulae deep brown; wings dusky with fine, brownish pubescence, nervures brown to black; legs deep reddish brown to black; posterior

basitarsi broad, approximately three to 3.3 times as long as broad, with surface partially obscured with long pile. Metasomal terga one to six dull, closely folliculated; metasoma with sterna strongly concave beneath, shiny, transversed by many fine lines; seventh ventral plates roughly quadrate, densely pilose along apical and lateroapical portions of discs (fig. 26).

*Female:* length 14 mm., wing length 8 mm.

Face with pile pale grey, concentrated principally about antennal bases; vertex with sparse, pale grey pile, becoming longer, finer, and lighter on lower regions of genal areas; mesoscutum with pile long, pale grey, and dense; scutellum with pile long and dense, particularly about lateral and posterior margins, completely obscuring surface; mesepisterna with pile very long and pale grey, weakly plumose; propodeum with strong clumps of light ochreus pile on lateroposterior margins, becoming much shorter and sparser towards pedicel; legs with pile pale grey, tending to ochreus on hind legs; metasomal terga one to five with broad apical band of pure white pubescence; metasomal tergum one with lateral fringes of white pile, disc covered with fine, pale grey, erect pile, not concealing surface; metasomal terga two to five with abundant, short, black and ferrugineous pile on discs; metasomal tergum six with pile long, semiappressed, and golden; metasomal sterna two to five with apical traces of a weak scopa: last metasomal sternum with apical clump of golden pile.

Antennae reddish brown, flagellar segments one and one-fourth times as long as broad, basal flagellar segment subequal to second; malar spaces three-eighths as long as wide, being broader at posterior mandibular articulation; clypeus weakly convex, closely punctate with very narrow, shiny interspaces; vertex dull and roughened. Prothoracic spines absent; mesoscutum dull with close, shallow punctures, particularly on lateral and posterior margins, impunctate area small to absent; scutellum closely punctate over posterior one half where it tends to rugose, anterior one-fourth shiny, impunctate; mesepisterna dull, weakly roughened, shallowly and densely punctate; propodeum with basal area broad, shallowly, obscurely, irregularly pitted, lateral and posterior faces dull; tegulae light brown; wings dusky, covered with very fine, brownish pubescence, nervures light brown; legs black tending to brown at apices; posterior basitarsi 3.2 times as long as broad. Metasomal terga one to five dull and very weakly punctured or folliculated; metasomal sterna dull with narrow, hyaline apical band to each sternum; last

metasomal sternum weakly depressed apically, tending to hyaline and containing clump of golden pile.

*Distribution:* Colorado: Estes Park; Glen Haven. Nebraska: Ashland; South Bend. South Dakota: Mobridge. Manitoba: Winnipeg; Cormorant Lake; Aweme. Wisconsin: Milwaukee.

*Flight records:* The species has been recorded as flying between May 18 and July 15.

*Plant records: Heuchera, H. hispida.*

The holotype from Boulder, Colorado, is in the collection of the Citrus Experiment Station, Riverside, California.

### GROUP VI—*robertsonii*

### *Colletes robertsonii* Dalla Torre

(Fig. 27)

*Colletes punctata* Robertson, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 62 (not *punctata* Moczary, 1877).
*Colletes robertsonii* Dalla Torre, 1896, Cat. Hymen., vol. 10, p. 44; Robertson, 1897, Trans. Acad. Sci. St. Louis, vol. 7, p. 315; 1904, Canadian Ent., vol. 36, p. 276; 1914, Ent. News, vol. 25, p. 73; 1926, Ecology, vol. 7, p. 378; 1928, Flowers and Insects, p. 10; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 395; 1951, Wasmann J. Biol., vol. 9, p. 193.
*Colletes robertsonii robertsonii,* Michener, 1951, *In* Muesebeck, *et al.*, Hymen. Amer. North of Mexico, U. S. D. A. Monog. no. 2, p. 1047.
*Colletes robustus* Swenk, 1904, Ent. News, vol. 15, p. 251; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; 1928, Univ. Colorado Studies, vol. 16, p. 99; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 395.
*Colletes robertsonii robustus,* Michener, 1951, *In* Muesebeck, *et al.*, Hymenoptera America North of Mexico, U. S. D. A. Monog. no. 2, p. 1048.

The synonymy of *robustus* Swenk and *robertsonii* D. T. is apparently correct, although I have not had opportunity to check the Robertson types in Illinois. There is a great deal of variability in both sexes throughout the range, even within small interbreeding units. The body color may range from light reddish brown to deep black; the prothoracic spines may be short or long; the puncturation of the mesoscutum and scutellum varies in density and size of punctures, usually the impunctate area of the mesoscutum of the female is large but in many individuals it is sparsely covered with fine punctures. Considering this variation I am not able, as Timberlake suggests, to recognize the Colorado-New Mexico populations as a distinct subspecies. The species is readily distinguished by the coarse, close puncturation over the entire body, the female having a nude depressed area on the apex of the last ventral segment which is basally rimmed by long, overlapping hairs. The males have the tegulae coarsely punctate and distinctive genitalia.

*C. robertsonii* closely resembles *C. metzi* Timberlake and *C. timberlakei* Stephen and can only be distinguished by examination of the seventh ventral plates and the capsule.

*Male:* length 11.5 mm., wing length 8.5 mm.

Pile of face long, white, and dense about antennal bases, inner orbital margins, and over clypeus; vertex with pile sparse and white; upper genal areas with pile long, rather dense, and white, becoming longer below; mesoscutum with pile rather sparse and tinged with pale grey; scutellum with a sparse covering of erect, pale grey to white pile, being most dense along anterolateral margins; mesepisterna with pile long, fine, and white, tinged with grey above; propodeum with dense lateral fringes of long, white pile, extending from upper lateroposterior margins towards pedicel, lateral and posterior faces with abundant, erect, pale grey pile; pile of legs very short, sparse, and white; first metasomal tergum with a distinct apical fascia of pure white pubescence, lateral fringes of pile weak, white, and reach apical fascia, disc with abundant, erect, whitish pile; metasomal terga two to five with fasciae broader, white, and dense, tapering off sharply at lateral faces; metasomal sterna with a very narrow fringe of short, white pile on the apex of segments two to five.

Antennae long, reddish brown, flagellar segments one and one-half times as long as broad; malar spaces one-fourth as long as broad; clypeus weakly convex, rather densely and finely punctate over apical one half and down median longitudinal line, latero-apical margins with punctures coarser, weakly striate, with shiny, linear interspaces; vertex dull, coarsely and rather densely punctate. Prothoracic spines about one and one-half times as long as width across base, sharp; mesoscutum very coarsely and densely punctate, punctures contiguous medially, impunctate area absent; scutellum very coarsely punctate over posterior three fourths, with shiny interspaces, punctures one-half puncture width apart, anterior one fourth shiny, impunctate; mesepisterna very densely punctate, punctures smaller in size than those of mesoscutum and scutellum, dull; propodeum with basal area very shallowly, quadrately pitted, pits obscure, lateral and posterior faces dull and roughened; tegulae deep brown to black, very coarsely punctate; wings dusky with abundant, deep fulvous pubescence, nervures brown; legs light brown to fulvous; posterior basitarsi four and one-half times as long as broad. Metasomal terga with fasciae lying in abrupt apical depressions, fascial depressions hyaline brown, shiny, impunctate;

metasomal terga one to four very densely, coarsely punctate, punctures no more than one-half puncture width apart; metasomal sterna shiny, finely folliculated; seventh ventral plates greatly expanded laterally, almost linear, with median and lateral margins reflexed, apical margins with long fringes of light fulvous pile (fig. 27).

*Female:* length 12.5 mm., wing length 8.5 mm.

Pile of face rather sparse and white, most dense laterad to antennal bases; vertex with the pile short, sparse, and pale grey; upper genal areas with pile white to pale grey becoming longer, finer, and whiter below; mesoscutum with pile very sparse, fine, short, and white; scutellum with a weak covering of short, white pile, particularly about lateral and posterior margins; mesepisterna with a sparse covering of long, fine, white pile; propodeum with rather dense fringes of long, white pile along lateroposterior margins, posterior face with sparse, erect, short, white pile; pile of legs tinged with light ochreus, rather long, particularly on posterior femora and tibiae; first metasomal tergum with apical fascia dense and white, lateral fringes of very short, white pile, weak, barely reaching the apical fascia, disc with sparse, very short, whitish pile; metasomal terga two to five with fasciae broad, white, and dense, fasciae abruptly tapering laterally; metasomal sterna with discs having abundant, erect, pale grey to light ochreus pile, forming a weak scopa.

Antennae reddish brown, flagellar segments as long as broad; malar spaces linear; clypeus weakly convex with a very weak to almost obscure longitudinal median sulcus; clypeus densely punctate, punctures not tending to be striate except on extreme apical portions, interspaces linear and shiny; vertex coarsely punctate, punctures no more than one-half puncture width apart; fascial foveae deep, extending well above inner margins of compound eyes and one third of way toward lateral ocelli, upper median margins weakly pointed toward lateral ocelli. Prothoracic spines long and coarse, as long as width across base; mesoscutum very densely and coarsely punctate, punctures giving surface a roughened appearance, impunctate area absent; scutellum very coarsely punctate over posterior three fourths, punctures one-half to one puncture width apart, anterior face shiny, impunctate; mesepisterna very densely punctured with fine punctures, much smaller than those of mesoscutum or scutellum, punctures almost contiguous, surface dull; propodeum with basal area obscurely pitted, pits varying in shape from quadrate to irregular, lateral and posterior faces very dull and roughened;

tegulae dark brownish hyaline; wings dusky, densely covered with abundant, deep fulvous pubescence, nervures brown; legs deep brown to black; posterior basitarsi three and one-half times as long as broad. Metasomal terga with apical fasciae in abruptly depressed apical margins, fascial depressions light brownish hyaline, impunctate; metasomal terga one to three coarsely, densely punctate, punctures no more than one-half puncture width apart, interspaces moderately dull; metasomal sterna dull, densely and finely folliculated, last metasomal sternum with apical one-half sharply depressed, impunctate, with a basal fringe of long, overhanging, fulvous pile.

*Distribution:* The species has been recorded from the following states: Illinois, Mississippi, Missouri, Iowa, Minnesota, South Dakota, Nebraska, Kansas, Oklahoma, New Mexico, Colorado, and Wyoming, as well as from the Province of Manitoba in Canada. Peripheral localities include: Carlinville, Illinois; Shuqualak, Mississippi; San Jose, New Mexico; Texas County, Oklahoma; Grand Canyon, Arizona; Aladdin, Wyoming; and Transcona, Manitoba.

*Flight records:* The species has been recorded as flying between June 8 and August 31.

*Plant records: Amorpha canescens, Monarda punctata occidentalis, Petalostemon candidus, Petalostemon violaceus.*

The holotype of *punctata* Robertson (*robertsonii* D. T.), a male, number 2234, from Carlinville, Illinois, is in the Illinois State Natural History Survey Collections, and that of *robustus* from Neligh, Nebraska, is in the collection of the University of Nebraska.

### *Colletes metzi* Timberlake

(Fig. 30)

*Colletes metzi* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 192.

Timberlake (1951) described the male of *metzi,* basing the description of the seventh ventral plates, not on the designated holotype, but on the paratype. Subsequent examination of the seventh ventral plates shows them to be two different species, with the original description referring to the new species *timberlakei.*

This species and *timberlakei* are so similar to *robertsonii* that the only positive way to distinguish among them is by an examination of the seventh ventral plates. For all practical purposes, the capsules of the three species are identical.

Although several specimens of *timberlakei* have been examined, *metzi* remains unique.

*Male:* Identical with *robertsonii,* except for the seventh ventral plates. Disc of each plate composed of two distinct parts; basal portion bare, similar to that of *robertsonii* but reduced in size; apical portion lobate and weakly chitinized, with dense covering of long pile; apical part united to basal at the medioapical margins; apical part divisible into lateral and median halves on basis of hair patterns, lateral half with pile short and fine, median half with pile long, coarse, and dense (fig. 30).

The holotype from Boulder, Colorado (Metz) is in the American Museum of Natural History.

*Colletes timberlakei* sp. nov.

(Fig. 31)

Timberlake first based his concept of *robertsonii* on what is now the type of this species. This error was corrected in his most recent paper (1951) after he had opportunity to make genitalic observations. The two species are so close that accurate determination is impossible without the removal of the seventh ventral plates. Contrary to Timberlake, I find that the penis valves (sagittal rods of Timberlake) are convoluted to the same degree as those of *metzi* and *timberlakei* but the dorsal convolution is often less obvious on removal of the capsule. The seventh ventral plates of *timberlakei,* while having similar basal areas to those of *robertsonii,* have broad, median apical expansions. There are other very minor differences mentioned by Timberlake, which do not hold true when the entire range of the species is considered. The tegulae of *timberlakei* are very finely punctate, and the prothoracic spines are usually shorter, about as long as broad. These characters hold true in the western plains, where *robertsonii* has the coarsely punctate tegulae and usually long prothoracic spines. In the eastern extent of the range, even these characters fail. Supplementary males from Boulder, Colorado, and from Wyoming are now available. In addition I have two females taken with the two males at Lusk, Wyoming, on July 14, 1937, by C. L. Johnson. There are no obvious differences between these female specimens and those of *robertsonii,* but I shall arbitrarily designate these as females of *timberlakei,* solely on the basis of the collection data.

*Male:* length 10.5 mm., wing length 7.5 mm.

The males very closely resemble those of *robertsonii* and can only be distinguished with certainty on the basis of the seventh

ventral plates. Seventh ventral plates with transverse basal area much as in *robertsonii,* however with median apical areas with broad membranous expansions, making plates roughly quadrate, tapering slightly laterally, surface area rather densely clothed with long hairs, particularly on medioapical and lateroapical portions, apical margins with a long fringe of tawny pile; penis valves of capsule with dorsal convolutions just slightly greater than that of *robertsonii* (fig. 31).

*Female:* The association of this female with the male is based exclusively on collection data, having been found at the same place and at the same time with males which have proved to be solely those of *metzi.* There is no distinctive morphological character evident to me by which this species can be distinguished from *robertsonii.*

*Distribution:* Holotype, male, Boulder, Colorado, August 14, 1935 (C. D. Michener). Paratypes: 1 male, Boulder, Colorado, August 14, 1935 (C. D. Michener); 2 males, Boulder, Colorado, July 21, 1935 (C. D. Michener) on *Petalostemon;* 1 male, Torrington, Wyoming, July, 1930 (G. B. Fairchild); 2 males, 1 female, Lusk, Wyoming, July 14, 1937 (C. L. Johnson); 1 female, Lusk, Wyoming, July 14, 1937 (R. H. Beamer).

The holotype is in the Snow Entomological Collections of the University of Kansas.

### *Colletes larreae* Timberlake

(Fig. 28)

*Colletes larreae* Timberlake, 1951, Wasmann J. Biol., vol. 9, pp. 193.

This is a close relative of *C. robertsonii* but is readily distinguishable from that species. Both sexes have the malar spaces long, as long as wide in the male and two-fifths as long as wide in the female. The terga are very sparsely punctate to almost folliculated and shiny and the prothoracic spines are vestigial or absent. It is much smaller than *robertsonii.* The last ventral sternum of the female has the apical one half sharply depressed and partially concealed with a long fringe of basal pubescence; the fascial foveae are deep and broad; and the thorax is coarsely punctate, much as in *robertsonii.* The seventh ventral plates of the male closely resemble those of *robertsonii;* however, they are much narrower and extend laterally to a greater degree; there is a fringe of pile on the medioapical margins rather than along the entire apical margin as in *robertsonii.*

*Male:* length 10 mm., wing length 7 mm.

Pile of face very long, white, and dense, concealing the clypeus, antennal bases, and supra-antennal regions; vertex with pile long, fine, and white; genal areas with upper surfaces having abundant, long, erect, white pile, pile becoming longer, finer, and pure white below; mesoscutum with pile long, white, and dense, tending to partially conceal surface; scutellum with pile predominantly white about lateral and posterior faces, becoming tinged with grey medially; mesepisterna with pile long, dense, and white; propodeum with dense, long, white fringes on lateroposterior margins, extending well down toward pedicel, lateral and posterior faces with abundant, erect, whitish pile; legs with pile long, white, and moderately dense, particularly on femora; first metasomal tergum with apical fascia narrow, moderately dense, and white, lateral fringes of pile white and extending to apical fascia, disc with abundant, long, erect, whitish pubescence; metasomal terga two to five with fasciae broad, white; metasomal terga three to six with abundant, erect, tawny to whitish pile on discal areas; metasomal sterna with weak apical fasciae or fringes of pile expanded slightly medially and composed of shorter, greyer pile in these medial areas.

Antennae long, dark brown to black, flagellar segments one and one-half times as long as broad; malar spaces as long as broad; clypeus convex, rather finely and densely punctate over basal two thirds, punctures becoming very sparse and weakly striate on apical one third, apical one third shiny, virtually impunctate; vertex rather densely punctate with shiny interspaces; fascial foveae just distinguishable, extending above inner orbital margins. Prothoracic spines absent; mesoscutum rather densely and coarsely punctate over anterior one half and lateral faces, impunctate area large; scutellum densely, rather coarsely punctate over posterior one half, punctures no more than one-half puncture width apart, anterior one half shiny, impunctate; mesepisterna densely punctate, punctures smaller than those of mesoscutum, no more than one-half puncture width apart above, tending to one puncture width apart on lower posterior faces; tegulae deep brown hyaline; wings whitish hyaline with sparse, light fulvous pubescence on apical portions, nervures brown; legs black; posterior basitarsi four times as long as broad. First metasomal tergum shiny, very finely and sparsely punctate, punctures two to four puncture widths apart; second metasomal tergum with punctures much as first, punctures slightly more dense; metasomal sterna moderately shiny and very finely roughened; seventh ventral plates narrow, transverse, with median

apical margins protruding, moderately long fringes of tawny to light ochreus pile along apicomedian margins, extreme lateral portions of each plate often reflexed (fig. 28).

*Female:* length 12 mm., wing length 8 mm.

Pile of face long, dense, and white, particularly about antennal bases and inner orbital margins, however clypeus having sparse, overhanging, white pile; vertex with pile dense and white in ocellar triangle; upper genal areas with pile short, fine, and white, becoming much longer and finer below, a very weak fringe of short, appressed, white pubescence immediately posterior to each compound eye; mesoscutum with the pile long, tinged with pale grey, and moderately dense; scutellum with a dense fringe of pale grey to light ochreus pile about lateral and posterior faces; mesepisterna with pile long, white, and dense; propodeum with dense fringes of white to pale grey pile along lateroposterior margins, longest on dorsal face, becoming shorter toward pedicel, lateral faces bare, posterior face with abundant, erect, grey to white pile; anterior two pairs of legs with pile long on the femora and white to grey, pile of tibiae short and white to tinged with light ochreus; posterior legs with abundant, very long, plumose, light ochreus to pale grey pile; first metasomal tergum with apical fascia narrow, weak, and white, often interrupted medially, lateral fringes of short, white, dense pile extending to fascia, disc with abundant, erect, white pile; metasomal terga two to four with fasciae broad, rather weak, and white; metasomal terga two and three with very weak, white, basal fasciae, fasciae often concealed; metasomal sterna two to five with discal areas having abundant, erect, pale grey to whitish pile, forming a weak scopa.

Antennae deep brown to black, flagellar segments as long as broad; malar spaces two-fifths as long as broad; clypeus convex, rather densley and coarsely punctate, punctures tending to be weakly striate, no more than one-half puncture width apart above, tending to be slightly sparser apically; vertex finely and densely punctate with shiny interspaces; fascial foveae exceedingly deep and broad, extending well above inner orbital margins and two thirds of way from inner orbital margins to lateral ocelli. Prothoracic spines absent; mesoscutum densely and coarsely punctate over anterior half and lateral margins, impunctate area large; scutellum with posterior two thirds coarsely and densely punctate, punctures one-half to one puncture width apart and not at all striate, anterior face with a few, sparse, finer punctures to shiny

impunctate; mesepisterna with punctures much finer than those of the mesoscutum, densely and finely punctate, rather dull, punctures no more than one-half puncture width apart; propodeum with basal area shallowly and irregularly pitted, lateral and posterior faces dull and roughened; tegulae deep brown to black; wings dusky with a rather sparse covering of deep fulvous pubescence, nervures brown; legs deep brown to black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, very finely and sparsely punctate, punctures two to four puncture widths apart, surface with a deep metallic blue-black lustre; second metasomal tergum with punctures much finer and sparser than on first, maintaining a deep blue-black lustre; metasomal sterna dull, densely and finely folliculated, last metasomal sternum with apical one-half sharply depressed with a basal arcuate band of overhanging, light ochreus pile.

*Distribution:* Palm Springs, California, March 30, 1945 (Timberlake) on *Larrea divaricata* (holotype); Palm Springs, California, April 10, 1932, on *Larrea glutinosa* (Timberlake) (allotype); 1 male, Palm Springs, California, March 20, 1916 (C. L. Fox); 1 male, Tetley Park, San Bernardino Mountains, on *Barbaraea orthoceras,* May 8, 1940 (P. H. Timberlake) (paratypes).

Timberlake records one other male paratype which I have not seen, taken at Lovejoy Buttes, Mohave Desert, Los Angeles County, California, May 10, 1944 (Timberlake), on *Acamtopappus sphaerocephalus.*

Other material: 1 male from Olancha, Inyo County, California, May 20, 1937 (C. D. Michener), and 1 female from Welton, Arizona, taken on April 6, 1935 (A. L. Melander).

The holotype and allotype are in the collections of the Citrus Experiment Station, Riverside, California.

### *Colletes turgiventris* Timberlake

*Colletes turgiventris* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 196.

This is a sibling species to *C. larreae* Timberlake, with the malar spaces much shorter, approximately one-half as long as broad, and the first metasomal tergum sparsely covered by a few coarse punctures in both sexes. The seventh ventral plates and the capsules of the male are identical to those of *larreae,* and it does not seem at all impossible that this may eventually prove to be a subspecies of *larreae,* despite the gross difference in the length of the malar spaces.

*Male:* length 11 mm., wing length 7 mm.

Pile of face very long, dense, and white, completely concealing clypeus and antennal bases; vertex with pile pale grey and densest in ocellar triangle; upper genal areas with pile very long, tinged with pale grey to white, pile becoming much longer and finer below; mesoscutum with abundant, very long, dense, white to pale grey pile; scutellum with a dense covering of long, dusky pile, particularly dense on lateral and posterior margins; mesepisterna with pile long, fine, and white, tending to be somewhat grey above; propodeum with rather dense clumps of pile on upper latero-posterior margins, lateral and posterior faces with abundant, fine, erect, pale grey pile; pile of legs long, sparse, and whitish; first metasomal tergum with the apical fascia narrow, weak, and white, lateral fringes of pile weak and white, barely extending to apical fascia, disc with abundant, long, erect, pale grey pile over entire surface; metasomal terga two to five with fasciae narrow, rather weak, and white; metasomal terga three to six with discs having abundant, erect, pale grey pile, not at all concealing surface; metasomal sterna two to four with apical fringes of pale grey pile, pile much shorter medially.

Antennae long, deep brown to black above, flagellar segments one and one-third times as long as broad; malar spaces one-half as long as broad; clypeus convex, very finely and densely punctate over basal two thirds, punctures tending to be very weakly striate on latero-apical portions, apex shiny impunctate; vertex dull, rather coarsely punctate with punctures one-half puncture width apart. Prothoracic spines vestigial; mesoscutum rather coarsely and densely punctate over anterior one third and lateral margins, punctures one-half puncture width apart, impunctate area large, shiny; scutellum very densely, contiguously punctate on extreme lateral margins, posterior discal area deeply punctate with punctures one-half to one puncture width apart, becoming much sparser toward anterior faces, anterior face shiny impunctate; mesepisterna densely, almost contiguously punctate, with interspaces dull; propodeum with basal area not distinctly quadrately pitted but transversed by a number of longitudinal rugae, lateral and posterior faces dull and finely roughened; tegulae deep brownish to black hyaline; wings dusky with abundant, short, deep fulvous pubescence, most dense apically, nervures brown; legs black; posterior basitarsi four times as long as broad. First metasomal tergum shiny, deep bluish black, deeply and sparsely punctate, punctures two to four puncture widths apart; second metasomal tergum shiny black, punctures just appreciably

finer and closer than on first metasomal tergum, varying from one and a half to three puncture widths apart; metasomal sternum dull, very finely roughened; seventh ventral plates as in *larreae* (fig. 28).

*Female:* length 11 mm., wing length 7.5 mm.

Pile of face long, white, and dense, particularly about antennal bases and along inner orbital margins, with a few pale grey hairs overhanging clypeus; pile of vertex dusky to tinged with light ochreus, sparse, and erect; upper genal areas with pile short, tinged with yellowish, becoming much longer and whiter below; mesoscutum with pile pale grey to tinged with light ochreus, short, and rather dense; scutellum with pile tinged with ochreus, dense, particularly along lateral and posterior margins; mesepisterna with pile long, fine, and white; propodeum with dense fringes of long, pale grey pile along lateroposterior margins extending down toward pedicel, lateral faces with a few, short, pale grey hairs, posterior face with abundant, erect, pale grey pubescence extending in from lateroposterior fringes; anterior two pairs of legs with pile short, fine, and white, posterior pair of legs with abundant, long, erect pubescence, exceedingly plumose and tinged with light ochreus; first metasomal tergum with apical fascia broad, dense, and white, lateral fringes of very short, white pile not reaching to apical fascia, disc with sparse, erect, tawny to white pile; metasomal terga two to four with fasciae broad, dense, and white; fascia of the fifth metasomal tergum narrow and white; metasomal terga three to six with abundant, erect, pale grey pile on discal areas; metasomal sterna two, three, and four having posterior half of each disc with short, erect pile, forming a weak scopa.

Antennae long, deep brown, flagellar segments three-fourths as long as broad; malar spaces one-fourth as long as broad; clypeus convex, rather coarsely, striately punctate, with shiny interspaces, punctures much finer along a median longitudinal line; vertex deeply punctate with shiny interspaces, punctures one-half puncture width apart; fascial foveae very deep and broad, extending slightly over half way from inner orbital margins to lateral ocelli, just barely narrower than in *larreae*. Prothoracic spines very short and sharp; mesoscutum very densely and coarsely punctate over anterior one half and lateral margins, punctures less than one half puncture width apart, impunctate area small; scutellum finely and densely punctate about extreme peripheral margins, punctures coarse, approximately one-half puncture width apart on posterior half of disc, becoming much sparser anteriorly, punctures extend-

ing to extreme anterior face; mesepisterna very densely, almost contiguously punctate, interspaces dull, punctures somewhat smaller than those of mesoscutum; propodeum with basal area shallowly pitted, pits irregular, not at all uniformly quadrate, lateral and posterior faces dull and roughened; tegulae deep brownish black; wings dusky with abundant, deep fulvous pubescence, especially on apical portions, nervures dark brown; legs dark brown to black; posterior basitarsi three and one-half times as long as broad. First metasomal tergum shiny with a deep bluish-black metallic lustre, punctures small and sparse, two to four puncture widths apart; second metasomal tergum very finely punctate to coarsely folliculated, shiny; metasomal sterna very finely and densely folliculated, dull, last metasomal sternum with apical one-half abruptly depressed, shiny, with a basal arcuate band of overhanging, fulvous pile.

*Distribution:* Antioch, California, May 8, 1937 (R. M. and G. E. Bohart) (holotype); Antioch, California, May 11, 1937 (R. M. and G. E. Bohart) (allotype and paratype), on *Phacelia;* Banning, Riverside County, California, May 3, 1925 (P. H. Timberlake) on *Phacelia hispida* (paratype).

The holotype and allotype are in the collections of the Citrus Experiment Station, Riverside, California.

### *Colletes kansensis* sp. nov.

(Fig. 29)

The metapleural prominences of this species are strong, coarsely rugose, and with indistinct, deep brown rims, while the seventh ventral plates closely resemble those of *robertsonii.* This species is superficially similar to the *americanus* group because of the metapleural prominences; however I believe it is related to the *robertsonii* group. The capsule is more reminiscent of the *robertsonii* group than any others, while the puncturation of the metasomal terga approaches that of *robertsonii.*

*Male:* length 8.5 mm., wing length 6 mm.

Pile of face long, fine, and white, concealing basal portion of clypeus and antennal bases; vertex with pile sparse, erect, and white; upper genal areas with pile dense and white, becoming much finer and longer below; mesoscutum with a sparse covering of long, white pile, becoming much sparser on median discal area; scutellum with a narrow fringe of white to pale grey pile about lateral and posterior faces; mesepisterna with pile long, fine, and white; pro-

podeum with dense fringes of long, white pile on upper latero-posterior margins, lateral and posterior faces with a sparse covering of erect, pale grey pile; pile of legs short, sparse, and white; first metasomal tergum with a broad apical fascia of pure white pubescence, lateral fringes of pile weak, white, and reaching apical fascia, disc with a moderately dense covering of erect, pale grey pile, not concealing surface; metasomal terga two to four with fasciae broad, dense, and white, narrowed laterally; fifth metasomal tergum with a very narrow fringe of white pile; metasomal terga three to six with sparse, very short, fuscous, erect pile; metasomal sterna two to four with weak fringes of pale grey pile, pile short, particularly medially.

Antennae brown, flagellar segments one and one-half times as long as broad; malar spaces three-eights as long as broad; clypeus convex, finely and densely punctate over basal two thirds, punctures becoming sparser and weakly striate apically, apical one third shiny, impunctate; vertex densely and coarsely punctate with shiny interspaces, punctures no more than one-half puncture width apart; fascial foveae rather distinct, especially above where they are very narrow and extend medially from inner orbital margins. Prothoracic spines rudimentary; mesoscutum rather densely punctate over anterior half and extreme lateral margins, punctures one-half to one puncture width apart, becoming much sparser medially where they may be one to two puncture widths apart, impunctate area small; scutellum coarsely, irregularly punctate on discal area, punctures one-half to one and one-half puncture widths apart, extreme anterior face shiny, impunctate; mesepisterna densely and coarsely punctate with shiny, linear interspaces, punctures one-half puncture width apart; upper metapleura strongly protuberant, protuberances sharply rugose with a very narrow, deep brown to black rim; propodeum with basal area sloping sharply ventrally, obscurely and irregularly pitted, pits very shallow and irregular, lateral and posterior faces dull and roughened; tegulae deep brown; wings dusky with abundant, deep fuscous pile, nervures brown; legs brown to black; posterior basitarsi four and one-half times as long as broad. First metasomal tergum coarsely and densely punctate, punctures finer and sparser on extreme anterior face, punctures of discal area one-half to one puncture width apart with shiny interspaces; second metasomal tergum very finely and densely punctate with shiny interspaces, tergum with a very weak basal depression; metasomal sterna dull, finely and densely folliculated; seventh ven-

tral plates narrow, transversely extended with long fringes of whitish pile on excavated apical margins (fig. 29).

*Distribution:* Holotype male, Garden City, Kansas, June 15, 1949 (Michener-Beamer), taken from the flowers of *Monarda punctata occidentalis;* paratype male, Clark County, Kansas, 1962 feet, May (F. H. Snow).

The holotype is in the Snow Entomological Collections of the University of Kansas.

## GROUP VII—*nudus*

### *Colletes nudus* Robertson

(Fig. 32)

*Colletes nudus* Robertson, 1898, Trans. Acad. Sci. St. Louis, vol. 8, p. 43; 1904, Canadian Ent., vol. 36, p. 275; Cockerell, 1908, Proc. Ent. Soc. Washington, vol. 10, p. 67; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 48; Graenicher, 1910, Bull. Pub. Mus. Milwaukee, vol. 1, p. 228; Smith, 1910, Ann. Rept. New Jersey State Mus. for 1909, p. 695; Banks, 1912, Ent. News, vol. 23, p. 107; Criddle, *et al.*, 1924, Rept. Ent. Soc. Ontario, vol. 33, p. 99; Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 99; Robertson, 1928, Flowers and Insects, p. 10; Pearson, 1933, Ecolog. Monog., vol. 3, p. 384; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301; Brimley, 1938, Insects of North Carolina, p. 451; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 399; Michener, 1947, Amer. Midland Nat., vol. 38, p. 445.

*Colletes hydrophilus* Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 313; 1907, Univ. Colorado Studies, vol. 4, p. 240; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 47; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 399.

*Colletes vierecki* Swenk, 1905, Canadian Ent., vol. 37, p. 301; 1908, Univ. Nebraska Studies, vol. 8, p. 48.

This species, described from Illinois, is found sparingly distributed over America east of the Great Divide. The females are most likely to be confused with *robertsonii* or *metzi* but differ in not having the last metasomal sternum depressed apically and in having the first metasomal tergum sparsely and coarsely punctate, with punctures at least one to two puncture widths apart. The males of *nudus* are readily distinguished from *robertsonii* by their sparser tergal puncturation, strong admixture of black pile on the mesoscutum, and distinctive seventh ventral plates. Specimens from the south and southeastern states are slightly different from those from the north. Both sexes have the wings more dusky and the metasomal terga more sparsely punctate. The males have a few black hairs on the clypeus and frons, and in the females the fascial foveae are just appreciably smaller and less distinctly depressed. Due to the minuteness of the differences I do not consider them to warrant subspecific differentiation even though specimens from the south have been called dark-winged varieties. The

Colorado specimens designated as *Colletes hydrophilus* Cockerell are unquestionably *C. nudus* as Timberlake indicates and the slight difference in puncturation appears to be a random variable occurring throughout the range of this species.

*Male:* length 10.5 mm., wing length 8.5 mm.

Pile of face long and dense about antennal bases and over clypeus, pale grey to pure white; vertex with pile tinged with ochreus, sparse, and long, a few, slightly darker hairs; upper genal areas with pile long, sparse, and pale grey, becoming longer and much whiter on lower faces; mesoscutum with an admixture of pale grey and black pile, pile sparse medially; scutellum with a sparse covering of pale grey and black pile, particularly about peripheral margins; mesepisterna with pile fine, long, pale grey, and very plumose; propodeum with very weak fringes of long, pale grey pile on upper lateroposterior margins, lateral and posterior faces with sparse, erect, pale grey pile; pile of legs sparse, long, and white; first metasomal tergum with apical fascia narrow and white, interrupted or nearly interrupted medially, lateral fringes weak and pale grey, barely reaching apical fascia, disc with very sparse, short, pale grey, erect pile; metasomal terga two to five with fasciae narrow, weak, and white; metasomal terga three to five with the discs having very short, deep fuscous to brown, erect pile on discs, not at all concealing surface; metasomal sterna two to four with weak apical fringes of short, white pile.

Antennae long, deep reddish brown to brownish black, flagellar segments one and one-half times as long as broad; malar spaces one-fourth as long as broad; clypeus weakly convex, very densely, coarsely, rugosely punctate to apex; vertex shiny, sparsely and shallowly punctate; fascial foveae narrow and distinctly depressed, extending along upper inner orbital margins. Prothoracic spines short and sharp, three-fourths as long as width across base; mesoscutum very coarsely punctate, punctures one-half puncture width apart about anterior and lateral margins to one puncture width apart over median discal area, impunctate area absent; scutellum rather coarsely and deeply punctate, punctures of variable size, varying from one-half to one puncture width apart, only extreme anterior face impunctate, scutellum not at all striately punctate; mesepisterna deeply, coarsely punctate, punctures one-half to one puncture width apart with shiny interspaces; propodeum with basal area deeply, quadrately pitted, pits slightly longer than broad, lateral and posterior faces shiny and weakly roughened with a few

sharp rugae, particularly on upper lateroposterior margins; tegulae deep brown; wings dusky, very closely covered with fulvous pubescence, nervures light brown; legs reddish brown to brown; posterior basitarsi four and one fourth times as long as broad. First metasomal tergum shiny, sparsely and shallowly punctate, punctures three to four puncture widths apart; second metasomal tergum with surface finely punctate, punctures closer than on first, varying from one to three puncture widths apart; terga two to five distinctly depressed basally; metasomal terga two to five with apical fasciae lying in depressed rims, this depression most evident laterally; metasomal sterna dull, coarsely and sparsely folliculated; seventh ventral plates short, expanded laterally, with extreme lateral margins rounded, surface uniformly covered with abundant, fine, tawny pubescence (fig. 32).

*Female:* length 12 mm., wing length 9 mm.

Pile of face rather sparse, clumped principally above antennal bases and along inner orbital margins, pile white to pale grey; vertex with sparse, erect, black pile, particularly in ocellar triangle; upper genal areas with pile predominantly pale grey but with a few intermixed black hairs, pile becoming longer, denser, and whiter below; mesoscutum with a strong admixture of pale grey and black pile, black pile becoming most dense and most abundant on median discal surface; scutellum with a weak fringe of dusky grey pile about lateral and posterior edges, disc with abundant, erect, black pile; mesepisterna with pile long, white, and plumose; propodeum with long fringes of white pile on upper lateroposterior margins, lateral and posterior faces with a few, long, pale grey hairs; legs with pile long, plumose, white to tinged with ochreus, particularly on posterior femora, posterior tibiae with a few, shorter, black hairs on upper surfaces; first metasomal tergum with apical fascia weak and pure white, interrupted medially, lateral fringes very weak, short, and white, barely reaching apical fascia, disc with a few, very short, pale grey hairs on anterior face; metasomal terga two to five with fasciae weak and white, often interrupted medially; metasomal terga four and five with sparse covering of short, deep fuscous pile on discs; metasomal sterna with a very weak fringe of pale grey pile on apical margins, a few, erect, pale grey hairs on discal surface.

Antennae long, deep brown to black, flagellar segments as long as broad; malar spaces linear; clypeus weakly convex, very densely, coarsely, rugosely punctate to apex; vertex shiny, sparsely and shallowly punctate; fascial foveae deep, extending well above tops of compound eyes and at least half way to lateral ocelli. Prothoracic

spines rather long, coarse, and sharp, one and one-half times as long as width across base; mesoscutum coarsely and densely punctate, punctures coarser and slightly sparser on median discal area, impunctate area absent; scutellum very coarsely and deeply punctate, punctures one-half to one puncture width apart, not at all striate; mesepisterna coarsely, densely, contiguously punctate with linear interspaces; propodeum with basal area very deeply, quadrately pitted, lateral and posterior faces dull and very finely roughened, extreme upper portion of posterior face with a few sharp rugae, lateral and posterior faces separated by a weak ridge; tegulae deep brown to black; wings dusky, very densely covered with short, fulvous pubescence, nervures brown; legs deep reddish brown; posterior basitarsi three and one-half times as long as broad. First metasomal tergum shiny, coarsely punctate, punctures one to three puncture widths apart, becoming finer towards apical margins; second metasomal tergum with punctures closer, one to two puncture widths apart, being much finer along anterior and median faces; metasomal terga with fasciae lying in abrupt apical depressions, the depressions most evident laterally; metasomal terga two, three, and four abruptly depressed basally; metasomal sterna very coarsely and densely folliculated; metasomal sterna two to five with apical margins rimmed with light brownish hyaline.

*Distribution:* The species has been recorded from most of America east of the Rocky Mountains. Marginal localities include: Boulder, Colorado; Randall, Wisconsin; Cheboygan County, Michigan; Tweed, Ontario; Raleigh, North Carolina; Fort Lauderdale, Florida; Covington, Louisiana, and Eudora, Kansas.

Swenk (1908) also recorded the species as occurring in Arkansas and Texas.

*Flight records:* The species has been recorded from April 12 to 18 in Florida through August 19 in the more northerly and westerly regions of its range.

*Plant records: Melilotus alba, Monarda mollis, Verbena urticifolia, Symphoricarpos vulgaris.*

The lectotype of *nudus* from Carlinville, Illinois, is in the Illinois State Natural History Survey Collection, the type of *hydrophilus* from Boulder Canyon, Colorado, is in the Citrus Experiment Station, Riverside, Califronia, and that of *vierecki* from Anglesea, New Jersey, in the collections of the University of Nebraska. Specimen number 19933, a female, and 19787 are hereby designated as lectotype and lectoallotype of *nudus*.

## *Colletes carolinus* Mitchell

(Fig. 33)

*Colletes carolinus* Mitchell, 1951, J. Elisha Mitchell Sci. Soc., vol. 67, p. 233.
*Colletes ?distinctus,* Swenk (not Cresson), 1908, Univ. Nebraska Studies, vol. 8, p. 36.

Swenk in 1908 indicated *nitidus* Smith to be a synonym of *distinctus* on the basis of Smith's description. His illustration of the seventh ventral plates and description of the species is not that of *distinctus* but would appear to be more like that of *carolinus* Mitchell. I have not had opportunity to have *carolinus* compared with the type of *nitidus* but it is quite probable that *carolinus* may be a synonym of this poorly known species. Examination of Mitchell's specimen determined as *distinctus* convinces me that he followed the Swenk determination, for the males proved to be the undescribed sex of his new species *carolinus.*

This species was described from a series of females taken in North Carolina and Georgia. The present work contains a description of a neallotype. The males can readily be distinguished from closely related species by having the malar spaces as long as wide, a strong mixture of black pile on the vertex and thoracic dorsum, and the first metasomal tergum shiny and impunctate. In the females the malar spaces are one-half as long as wide, there is abundant black pile on the vertex and thoracic dorsum, and the fascial foveae extend almost to the lateral ocelli.

*Male:* length 10 mm., wing length 7 mm.

Pile of face dense, thick, and tinged with yellow; pile of vertex sparser, erect, and tending towards deep ochreus, concentrated principally in ocellar triangle; pile of genal areas rather short and tinged with light ochreus; mesoscutum and scutellum having light ochreus pile of discal areas intermixed with black pile, black pile concentrated principally on median discal area of mesoscutum and mediolateral areas of scutellar disc; pile of the mesepisterna long, plumose, and light ochreus; pile of legs rather short and light ochreus; metasomal tergal fasciae weak and easily removed by rubbing, fasciae pale grey becoming broader and denser on metasomal terga three to five; first metasomal tergum with lateral fringes of pale grey pile extending to apical fasciae, discal area with abundant, erect, pale grey pile; metasomal terga three to five with discs having abundant, short, erect, deep brown to black pile, not at all concealing the surface; metasomal sterna with fasciae weak and weakly expanded medially.

Antennae long, black above, deep reddish brown below, flagellar segments approximately one and one-fourth times as long as broad; malar spaces as long as broad; clypeus weakly convex, rather closely and densely punctate over basal two thirds, punctures not at all striate, apical one third sparsely punctate and shiny; vertex sparsely punctate with broad, shiny interspaces on the posterior portion. Prothoracic spines as long as the width across base, sharp; mesoscutum distinctly punctate, punctures much finer than those of the scutellum or mesepisterna, interspaces shiny, impunctate area large; scutellum very coarsely punctate to anterior margin, not at all striate, a weak longitudinal median sulcus extending to anterior margin; mesepisterna with upper half very deeply, rugosely punctate, almost pitted, punctures becoming sparser and finer with broad, shiny interspaces on latero-ventral portion; propodeum with basal area deeply pitted with quadrate pits, striae or rugae forming a few deep shiny pits on extreme upper portions of lateral and posterior faces; tegulae brownish-black with a few scattered punctures; wings testaceous covered with abundant, short, testaceous pile, nervures deep brown; legs reddish brown to black, tarsi and ends of tibiae tending to brown; posterior basitarsi five times as long as broad; first metasomal tergum shiny with a weak scattering of follicles becoming more evident at lateral surfaces, interspaces broad and shiny; metasomal terga two and three finely folliculated, shiny; metasomal sterna two to six somewhat coarsely folliculated rather than punctate, shiny; seventh ventral plates resembling *mandibularis* Smith but with greater lateral expansion and discal area completely covered with short, light ochreus pile (fig. 33).

*Female:* length 13 mm., wing length 7.5 mm.

Pile of face sparse, erect, and pale grey, not at all concealing surface; pile of vertex sparse, light ochreus except for a few intermixed ochreus to testaceous hairs, a very small patch of appressed, light grey pubescence immediately posterior to compound eye; pile of lower genal areas sparse, long, erect, and pale grey; mesoscutum with an admixture of light ochreus and black pile, black pile concentrated principally on median discal area between parapsidal lines; scutellum with a marginal fringe of ochreus pile bordered along inner margins by abundant black pubescence; mesepisterna with pile long, fine, and weakly tinged with ochreus; legs with pile light ochreus except on posterior tibiae where there are a number of very short, spinelike, black hairs particularly on basal half of the tibia; metasomal terga with white fasciae becoming

broadest on terga three and four; first metasomal tergum with fascia almost absent medially, broadening laterally but nowhere as strong as on other metasomal terga, tergum with a very weak, lateral fringes of white to pale grey pile just reaching apical fasciae, anterior portion of disc with a few, scattered, fine, pale grey hairs; second metasomal tergum with a very weak, virtually absent, basal fascia, evident only medially; metasomal terga three to five with abundant, short, erect, ochreus pubescence, not at all concealing the surface; metasomal sterna with weak apical fringes of pale grey pile, not sufficiently dense to form a fascia or a scopa.

Antennae long, brownish black, flagellar segments three-fourths as long as broad; malar spaces five-eighths as long as broad; clypeus strongly convex and densely punctate over basal two thirds, punctures becoming sparser, more striate, towards apical one third; vertex shiny and very sparsely and finely punctate, fascial foveae broad and weakly depressed along upper inner margins, reaching at least half way to ocelli at their upper extremity. Prothoracic spines short and blunt, roughly triangular; mesoscutum densely punctate over anterior half and lateral portions, punctures not as coarse as those of scutellum or mesepisterna; scutellum coarsely punctate over posterior five eighths of surface, punctures not at all striate and having shiny interspaces; mesepisterna densely, rugosely punctate, punctures contiguous over surface of mesepisterna; basal area of propodeum with deep, quadrate pits, median pits broader than long, upper lateral surfaces of posterior face of propodeum deeply, rugosely pitted with shiny surfaces, rugae becoming much weaker below; tegulae light brown and finely punctate; wings testaceous hyaline with abundant, short, ochreus pubescence, nervures light brown; legs black, posterior tibiae with a shallow longitudinal groove on upper posterior surfaces; posterior basitarsi three and one-half times as long as broad. First metasomal tergum shiny, impunctate, a few weak follicles scattered over surface; metasomal terga two and three much as first; metasomal sterna rather coarsely folliculated over posterior one half of each sternum.

*Distribution:* North Carolina: Southport (holotype and 4 paratypes); Fort Fisher (paratype); New River (neallotype). Georgia: Albany (paratype); Waycross (10 paratypes); Billy's Island, Okefenokee Swamp (2 paratypes). Florida: Indian Town (paratype); Winter Park (paratype); Royal Palm Park (paratype); Island Grove (paratype); Punta Gorda (paratype); Suwanee Springs; Bradenton; Dade City; Orlando; Biscayne Bay.

Flight records: March 8 to July 6.

*Plant records: Hypericum.*

The holotype is in the collection of T. B. Mitchell at Raleigh, North Carolina. The neallotype, New River, North Carolina, April-May, 1942 (G. E. Bohart), is in the United States National Museum.

### *Colletes brimleyi* Mitchell

(Fig. 34)

*Colletes brimleyi* Mitchell, 1951, J. Elisha Mitchell Sci. Soc., vol. 67, p. 231.

This is a close relative of *carolinus* Mitchell but smaller in size. The males have a few dark hairs on the mesoscutum but these hairs are more fuscous than black; the mesepisterna are more sparsely punctate below than in *carolinus,* with punctures two to three puncture widths apart; the males are only about 8 millimeters in length (compared with 10 millimeters in *carolinus*). The females are readily distinguished by their dense covering of ochreus to light ochreus pile combined with an impunctate first metasomal tergum.

*Male:* length 8.5 mm., wing length 6.5 mm.

Pile of face long, dense, and tinged with light ochreus, pile completely concealing clypeus; vertex with a few, light ochreus, erect hairs principally in ocellar triangle; pile of upper genal areas light ochreus, becoming pale grey below; mesoscutum with pile pale grey to light ochreus, occasionally a few, deeper ochreus hairs on scutellum but these hairs never black; scutellum almost completely concealed by a dense mat of light ochreus pile; mesepisterna with pile long, fine, and pale grey to light ochreus; pile of legs very short, fine, and pale grey; metasomal fasciae composed of weak, pale grey to light ochreus pubescence; first metasomal tergum with a lateral fringe of dusky grey pile extending to apical fascia, tergum with abundant, erect, dusky pile, not at all concealing surface; discal pile of terga four to seven a pale grey to light ochreus, not at all black or testaceous; sternal fasciae weak, composed of a very narrow fringe of pale grey pile.

Antennae long, reddish brown beneath and brownish black above, flagellar segments one and one-half times as long as broad; malar spaces there-fourths as long as broad; clypeus convex, very densely, contiguously, striately punctate over entire surface, punctures a little more separated at extreme apical margin; vertex dull, closely and deeply punctate. Prothoracic spines short and sharp, barely as long as width across base; mesoscutum very coarsely and densely

punctate, impunctate area small; scutellum densely almost contiguously punctate over lateral and posterior surfaces, medioanterior surface shiny and free from punctures; mesepisterna with upper one half closely, coarsely punctate, lower faces of mesepisterna with punctures sparser and interspaces shiny, punctures becoming feeble towards posterior margin of mesepisterna; propodeum with basal area deeply pitted with quadrate pits, lateral and posterior faces rugose and shiny, a few shallow pits on upper lateroposterior faces; tegulae light hyaline brown; wings dusky hyaline with abundant, short, ochreus to fuscous pubescence over surface, nervures brown; legs black tending to brownish on apices of tibiae and tarsi; posterior basitarsi four times as long as broad. First metasomal tergum shiny, very finely punctate, punctures approximately two puncture widths apart, becoming sparser medially; second metasomal tergum very finely punctate with punctures one to two puncture widths apart; metasomal sterna shiny, very sparsely folliculated; seventh ventral plates much as in *carolinus*, however with median reflexed portions greatly expanded (fig. 34).

*Female:* length 10 mm., wing length 7.5 mm.

Pile of face pale grey, erect, and most dense at antennal bases; genal areas with pile light ochreus, pile becoming longer and finer below; mesoscutum and scutellum with pile ochreus to deep ochreus with no admixture of black pile, pile rather dense and tending to obscure surface; mesepisterna with pile long, plumose, and pale grey; legs with pile very long, plumose, and pale grey; first metasomal tergum with fascia expanded laterally, almost absent medially, fascia white to slightly tinged with ochreus, tergum with lateral fringes of light ochreus pile extending to fascia, anterior portion of disc with abundant, erect, pale grey pile, not at all obscuring surface; fasciae of metasomal terga two to five broader than first, more dense, and a little whiter; metasomal terga five and six with discs having abundant, semierect, pale grey to light ochreus pile; metasomal sterna with a weak fringe of pale grey pile on extreme apical margins, a few, erect, scattered, ochreus hairs on discal area.

Antennae deep brown to black, flagellar segments three-fourths as long as broad; malar spaces three-eighths to one-half as long as broad; clypeus weakly convex with a very faint median longitudinal sulcus, surface closely and densely striately punctate to apex; vertex shiny and finely punctate; fascial foveae distinct, not reaching half way to lateral ocelli at upper extremity. Prothoracic spines

short and sharp, barely as long as width across base; mesocutum very densely and coarsely punctate, impunctate area small; scutellum coarsely and densely punctate over posterior three-fourths, anterior one fourth shiny and sparsely punctate, a very weak trace of a longitudinal median line extending to anterior margin of scutellum; mesepisterna coarsely and densely punctate, surface dull; basal area of propodeum deeply pitted, upper portions of lateral and posterior faces of propodeum transversed by numerous weak rugae, surface dull; tegulae light hyaline brown; wings dusky with abundant, short, ochreus to fuscous pubescence, particularly on apical half, nervures brown; legs deep reddish brown; posterior basitarsi two and three-fourths times as long as broad. First metasomal tergum shiny, very feebly punctate or folliculated, follicles just barely discernible towards lateral faces; second metasomal tergum sculptured much as first; metasomal sterna rather coarsely folliculated, shiny, follicles coarsest on apical half of each sternum.

*Distribution:* North Carolina: Fort Macon (holotype, allotype, and 19 paratypes); Morehead (paratype); Laurel Hill (paratype). Georgia: St. Marys. Florida: Inverness (32 paratypes); Miami (paratype); Island Grove (paratype); Tarpon Springs (paratype); Orlando; Ormond; Biscayne Bay. New Jersey: Camden County.

*Flight records:* The species has been recorded as flying between February 24 and May 11.

*Plant records: Ilex.*

The holotype is in the collection of the North Carolina State College of Agriculture and Mechanic Arts, Raleigh, North Carolina.

## GROUP VIII—*americanus*

### *Colletes americanus* Cresson

(Fig. 35)

*Colletes americanus* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 167; 1872, Trans. Amer. Ent. Soc., vol. 4, p. 248 (questionable); Putman, 1876, Proc. Davenport Acad. Sci., vol. 1, p. 195 (questionable); Patton, 1879, Proc. Boston Soc. Nat. Hist., vol. 20, p. 142; Evans, 1896, Canadian Ent., vol. 28, p. 12; Cockerell, 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 19 (questionable); 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 51 (questionable); 1898, Zoologist, ser. 4, vol. 2, p. 312 (questionable); 1898, Bull. Denison Univ., vol. 11, p. 43 (questionable); 1898, Bull. Univ. New Mexico, vol. 1, p. 43 (questionable); 1899, Catálogo de las Abejas de Mexico, Secretaria de Fomento, p. 4 (questionable); Birkmann, 1899, Ent. News, vol. 10, p. 244 (questionable); Cockerell, 1901, Canadian Ent., vol. 33, p. 282 (questionable); 1901, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 125 (questionable); 1902, Amer. Nat., vol. 36, p. 810 (questionable); 1903, Psyche, vol. 10, p. 74 (questionable); Robertson, 1904, Canadian Ent., vol. 36, p. 276; Pierce, 1904, Univ. Nebraska Studies, vol. 4, p. 24; Cockerell, 1905, Psyche, vol. 12, p. 68; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292

(questionable); Snow, 1906, Trans. Kansas Acad. Sci., vol. 20, p. 136 (questionable); Robertson, 1906, Science, vol. 23, p. 309; Lovell, 1907, Canadian Ent., vol. 39, p. 364; Cockerell, 1908, Proc. Ent. Soc. Washington, vol. 10, p. 67; Smith, 1910, Ann. Report New Jersey State Museum for 1909, p. 694; Robertson, 1914, Ent. News, vol. 25, p. 70; Viereck, 1916, Connecticut Geol. Nat. Hist. Survey Bull., no. 22, p. 741; Cresson, 1916, Mem. Amer. Ent. Soc., no. 1, p. 106; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario for 1919, p. 132; Clements and Long, 1923, Carnegie Inst. Washington Publ., no. 336, p. 249 (questionable); Robertson, 1926, Ecology, vol. 7, p. 387; 1926, Psyche, vol. 33, p. 116; Leonard, 1926, Cornell Univ. Agr. Exper. Sta. Mem., no. 101, p. 1021; Robertson, 1928, Flowers and Insects, p. 10; Pearson, 1933, Ecol. Monographs, vol. 1, p. 384; Brimley, 1938, Insects of North Carolina, p. 451; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 404; Michener, 1947, Amer. Midland Nat., vol. 38, p. 445.

Considerable confusion has existed and still exists when dealing with this species. The closely related *mitchelli* and *annae* Cockerell are very difficult to separate from *americanus* and there is some probability that *annae* may eventually prove to be a montane subspecies of *americanus*. The males of *annae* have the punctures of the mesepisterna coarse and separated by broad shiny interspaces in contrast to the finely punctured and roughened pleura of *americanus*, the rims of the metapleural prominences are narrower and the prothoracic spines slightly longer in *annae*. The female of *annae* lacks the broad testaceous rims of the metapleural prominences which occur in *americanus*, the precoxal spines are much shorter and the pile of the body tends to be finer and tinged with light yellow.

The seventh ventral plates of *mitchelli* are roughly square with the pile of the dorsal surface restricted to the median portions compared to the larger quadrangular plates of *americanus*. The females of *mitchelli* lack the testaceous rim completely, having but a weak black margin.

I have not had access to the specimens recorded from Arizona (Snow), New Mexico (Cockerell), Colorado (Cockerell), Utah (Putman) or Texas (Cockerell and Cresson) and therefore have not been able to verify or refute these determinations. I strongly question their validity as *americanus* for on the basis of the material at hand the western limits of *americanus* appear in the Carolinian zone of the plains states. There is a strong possibility that the specimens from Colorado, Utah, and Texas were either *solidaginis* or *mandibularis* for these species are superficially similar.

*Male:* length 9 mm., wing length 6 mm.

Pile of face dense over clypeus and about antennal bases, tinged with light yellow, especially above; vertex with pile yellowish to dusky yellowish, concentrated principally in ocellar triangle; upper

genal areas with pile yellowish to dusky yellowish, pile becoming longer, finer, and pure white below; mesoscutum with pile long and dense over anterior one half and lateral margins, pile strongly tinged with a dusky yellow; scutellum with a broad lateral and posterior fringe of dusky yellow to light ochreus pile; mesepisterna with pile long, fine, pale grey above, becoming whiter below; propodeum with long fringes of dusky pile along lateroposterior margins, fringes longest and most dense above, becoming progressively shorter and weaker toward pedicel, lateral and posterior faces with a sparse covering of erect, pale grey pile; pile of legs short, sparse, and pale grey to white; first metasomal tergum with apical fascia weak but complete, pubescence tinged with duskiness, especially at median portions, lateral fringes of dusky pile weak, barely reaching apical fascia, disc, especially anterior portion, with abundant, erect, pale grey to dusky pile; metasomal terga two to five with fasciae broad, dense, and pale grey; metasomal terga three to six with discs having abundant, erect, light yellowish to dusky pile; metasomal sterna two to four with narrow apical fringes of pale grey pile.

Antennae reddish brown to dark brown above; malar spaces one-third as long as broad; clypeus short, weakly convex, very densely and finely punctate to apex, punctures slightly larger and tending to be very weakly striate apically; vertex dull, finely and shallowly punctate. Prothoracic spines sharp, not as long as width across base; mesoscutum very finely and shallowly punctate with broad, shiny interspaces, punctures one to two puncture widths apart, impunctate area small; scutellum densely, almost contiguously punctate over posterior one third, punctures becoming sparser and more distinct on median discal area, anterior one third shiny, impunctate; mesepisterna shallowly punctate, punctures of same size as mesoscutum, dense above, becoming sparser below; metapleural prominence strong with a broad hyaline testaceous rim, abruptly declivous beneath; propodeum with basal area narrow and sloping rather sharply ventrally, shallowly, quadrately pitted, lateral and posterior faces dull and weakly roughened; tegulae light hyaline brown; wings dusky with abundant, light fulvous pubescence, nervures light brown; legs reddish brown to black basally; posterior basitarsi four times as long as broad. First metasomal tergum shiny, finely and rather sparsely punctate laterally, punctures one to two puncture widths apart, punctures becoming sparser and folliclelike medially where surface is almost impunctate; second metasomal tergum dull,

finely and densely folliculated, weakly depressed basally; metasomal sterna dull, finely, rather obscurely folliculated; seventh ventral plates roughly quadrate with a broad transverse basal rim of pile, extreme lateral margins nonplumose and hyaline (fig. 35).

*Female:* length 10 mm., wing length 6.25 mm.

Pile of face strongly tinged with yellow, concentrated principally about antennal bases and lower inner orbital margins, a few sparse, finer hairs on clypeus, not at all concealing surface; vertex with pile tinged with ochreus, dense in ocellar triangle; upper genal areas with pile strongly tinged with yellow, pile becoming finer and sparser below, a very narrow, weak rim of appressed pubescence immediately posterior to each compound eye; mesoscutum with a dense covering of yellow to light ochreus pile, being most dense about anterior and lateral margins; scutellum with a broad lateral and posterior rim of dusky yellowish to light ochreus pile; mesepisterna with pile long, fine, pale grey above, tending to pure white below; propodeum with long fringes of light yellowish pile along lateroposterior margins, fringes longest and most dense on dorsal surface, lateral faces with a few overhanging hairs from metapleural propodeal margin, posterior face with abundant, erect, pale grey pile; pile of anterior two pairs of legs short and white to pale grey, rather sparse, posterior legs with pile long, plumose, and pale grey; first metasomal tergum with apical fascia weak and broad, often interrupted medially, pubescence dusky, lateral fringes of pile weak, becoming short and barely reaching apical fascia, disc with abundant, erect, dusky pile, particularly on anterior face; metasomal terga two to five with apical fasciae broader, denser, and dusky to pale grey; metasomal terga three to six with discs having abundant, erect, pale grey to fuscous pile; metasomal sterna with very weak apical fringes of pale grey pile.

Antennae reddish brown to black above, flagellar segments about as long as broad; malar spaces very short, one-sixth as long as broad; clypeus short, weakly convex, tending to be flattened medially, densely, obscurely punctate to apex, punctures tending to become somewhat more striate apically; vertex shiny, very finely and rather densely punctate; fascial foveae rather indistinct, weakly rounded dorsally and not extending above inner margin of the compound eyes. Prothoracic spines long and sharp, at least longer than width across base; mesoscutum finely and densely punctate, punctures no more than one-half puncture width apart about anterior and lateral margins, impunctate area small; scutellum densely, obscurely

punctate over posterior one third and lateral margins, punctures becoming more distinct and shallower on median discal area, anterior one-third shiny, impunctate; mesepisterna tending to be dull, very densely and shallowly punctate, punctures almost contiguous above and along the anterior margin, becoming finer, sparser, and more obscure posteriorly; metapleural prominence strong with a broad, testaceous rim, abruptly declivous beneath; propodeum with basal area narrow, sloping rather sharply ventrally and irregularly, quadrately pitted, lateral faces shiny, posterior faces shiny and rather finely and sparsely punctate; tegulae light hyaline brown; wings dusky with abundant, very light fuscous pile, nervures brown; legs brown, becoming somewhat blacker basally; precoxal spines short, about twice as long as wide; posterior basitarsi four times as long as broad. First metasomal tergum shiny, very finely and sparsely punctate laterally, punctures becoming sparser and follicle-like on median surfaces where they may be three to six follicle widths apart; second metasomal tergum densely and coarsely folliculated, surface dull; metasomal sterna two to five dull, very densely and coarsely folliculated.

*Distribution:* The species abounds in the eastern portions of America, becoming scarcer in the western great plains. Marginal records include Bryson City, North Carolina; Atlanta, Georgia; Cartersville, Georgia; Hattiesburg, Mississippi; Orono and Booth, Maine; Tenaga and Kazabazua, Quebec; Aweme, Manitoba; Phillip, South Dakota; and Lawrence, Kansas. (Map 3.)

*Flight records:* This is an autumnal species, having been recorded between August 12 and October 30.

*Plant records: Aster, Chrysopsis microcephala, Solidago.*

The holotype from Massachusetts is in the Academy of Natural Sciences of Philadelphia.

### *Colletes annae annae* Cockerell

(Fig. 36)

*Colletes annae* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 48; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 24; 1898, Bull. Denison Univ., vol. 11, p. 43; 1898, Bull. Univ. New Mexico, vol. 1, p. 43; 1905, Psyche, vol. 12, p. 87; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292.
*Colletes crucis* Cockerell, 1902, Ent. News, vol. 13, p. 304; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292 (new synonymy).
*Colletes cockerelli* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 221 (new synonymy).

An examination of the type of *crucis* Cockerell reveals it to be identical with *annae* Cockerell, both of which have been virtually

unknown except for the originally described specimens. The species is very sparsely distributed throughout the southwestern portion of the United States and northern Mexico, apparently an autumnal polytropic member of the *americanus* group, closely related to *solidaginis* Swenk and *americanus.*

Recently Timberlake described a new species, *cockerelli,* from two females taken in Arizona which resemble the males of *annae* closely in puncturation characteristics as well as in the distribution of the pubescence. These I believe to be the females of the poorly known *annae.*

The females can readily be distinguished by having the precoxal spines short, yet well developed; the metapleural prominences weak without a distinct testaceous rim; and the pile of the typical specimens tinged with light yellow.

The males closely resemble *C. americanus* except in having the mesepisterna with the punctures coarse and separated by broad, shiny interspaces; in having the rims of the metapleural prominences much narrower; and in having the prothoracic spines somewhat longer.

*Male:* length 8 mm., wing length 5.5 mm.

Pile of face long, dense, and very lightly tinged with yellow, completely concealing clypeus and antennal basal region as high as median ocellus; vertex with abundant pile, light ochreus; upper genal areas with pile dense, light ochreus, becoming longer, finer, and whiter below, a very narrow rim of appressed, whitish pubescence immediately posterior to each compound eye; mesoscutum with abundant, erect pile tinged with light yellow; scutellum with a very dense lateral and posterior fringe of plumose, light ochreus pile; mesepisterna with pile long, fine, white below, tending to be tinged with yellow above; propodeum with dense fringes of long, yellowish pile along lateroposterior margins, fringes most dense dorsally, lateral and posterior faces with abundant, erect, light yellowish pile; pile of legs short, moderately dense, and white to tinged with light yellowish; first metasomal tergum with apical fascia very broad, dense, and yellowish, lateral fringes of long yellowish pile extending to apical fascia, disc with abundant, long, yellowish pile obscuring surface; metasomal terga two to five with fasciae very broad, dense, and tinged with light yellow; second metasomal tergum with a broad, dense basal fascia; metasomal sterna two to four with dense apical fringes of pale grey pile, slightly broadened medially.

Antennae reddish brown, flagellar segments one and one-half times as long as broad; malar spaces narrow, one-fourth as long as broad; clypeus short, weakly convex, very finely and densely punctate over basal two thirds, punctures not at all striate and close, apex and lateroapical margins with punctures sparser and tending to be weakly striate; vertex shiny, finely and sparsely punctate. Prothoracic spines long and needlelike, at least twice as long as width across base; mesoscutum distinctly punctate with shiny interspaces, punctures one-half to one puncture width apart, impunctate area small; scutellum very finely, densely, contiguously punctate about lateral and posterior one third, punctures becoming sparser and more distinct on median and anterior discal area; mesepisterna with punctures just appreciably coarser than those of mesoscutum, separated by one-half to one puncture width, interspaces shiny; propodeum with basal area broad, deeply, quadrately pitted, lateral and posterior faces shiny, posterior face finely and sparsely punctate; metapleural prominence with a narrow testaceous rim; tegulae light hyaline brown; wings whitish hyaline with a sparse covering of light pubescence, nervures light brown; legs brown, bases and apices of tibiae very light brown, intermediate area darker brown, tarsal segments light yellowish brown. First metasomal tergum shiny, impunctate, a few, very fine punctures or follicles evident on lateral margins; second metasomal tergum finely and sparsely folliculated, interspaces shiny; metasomal sterna shiny, finely and sparsely folliculated; seventh ventral plates much as in *americanus* but with discal pubescence not nearly so strong along median portion, pubescence in *annae* extending to extreme lateral margins (fig. 36).

*Female:* length 9.5 mm., wing length 6 mm.

Pile of face short, moderately sparse, more densely concentrated about antennal bases and lower inner orbital margins where it tends to be semiappressed; clypeus weakly covered with fine, nonplumose pile, not at all concealing surface; vertex with sparse pile concentrated principally in ocellar triangle; upper genal areas with pile long and yellowish, tending to be longer, finer, and pale grey to white below, a narrow rim of appressed, whitish pubescence immediately posterior to each compound eye; mesoscutum with abundant, short, rather plumose, yellowish pile, tending to obscure surface; scutellum with posterior and lateral portions covered with plumose, yellowish pile; mesepisterna with weak covering of fine, long, pale grey to white pile, becoming much shorter on upper

faces; propodeum with long fringes of dusky pile along lateral and posterior margins, pile longest and most dense on dorsal surface, becoming shorter below; anterior two pairs of legs covered with long, whitish pile, posterior femora and tibiae with long, curved, plumose hairs over surface, hairs almost pure white; first metasomal tergum with a dense, appressed covering of long, whitish pile, lateral fringes of light yellow to pale grey pile extending to apical fascia; metasomal terga two to four with apical fasciae broad and pure white; second metasomal tergum with a dense, white basal fascia; third metasomal tergum with a weak, white basal fascia; sternal fasciae absent; sixth metasomal tergum with appressed, dark brown pile.

Antennae light reddish brown, becoming lighter toward base of flagellum; malar spaces narrow, approximately one-fifth as long as wide; clypeus weakly protuberant, rather rugosely punctate over entire surface; vertex shiny, impunctate. Prothoracic spines long, directed dorsolaterally; mesoscutum coarsely and closely punctate on anterior half, punctures becoming sparser about median impunctate area, which is large, surface uniformly coarsely punctate about anterior, lateral, and posterior portions; scutellum weakly rugosely punctate over posterior half, anterior half shiny, impunctate; mesepisterna with deep, coarse punctures separated by narrow, shiny interspaces, punctures somewhat smaller and denser above; metapleural prominence weak with a very narrow, deep testaceous to dark brown rim, not abruptly declivous beneath; propodeum with basal area having shallow, quadrate pits, lateral and posterior faces shiny, impunctate; tegulae light brown; wings whitish hyaline with sparse covering of light pubescence, nervures light brown; legs reddish brown, anterior coxae with spines approximately twice as long as wide; posterior basitarsi four and one-half times as long as wide. First metasomal tergum with disc shiny and shallowly punctate, punctures more evident at extreme lateral margin where they are still obscure; metasomal terga two and three with discs shallowly folliculated; metasomal sterna shiny, very coarsely and densely folliculated on apical one half of each sternum.

The color of the pile of the typical specimens of *annae* is prone to variation and in many specimens the yellowish tinge, so vivid on the types, is not evident and the pile tends to tawny grey or whitish.

*Distribution:* Two males, Las Cruces, New Mexico, August 27 (T. D. A. Cockerell) on *Solidago canadensis arizonica;* one female, Phoenix, Arizona, October 16 (T. D. A. Cockerell) on *Baccharis;*

one female, Tempe, Arizona, October 28 (T. D. A. Cockerell) on *Baccharis*. (Map 3.)

The holotype of *annae* from Mesilla, New Mexico, is in the United States National Museum, that of *crucis* from Las Cruces, New Mexico, is also in the United States National Museum, and that of *cockerelli* from Phoenix, Arizona, is in the Citrus Experiment Station, Riverside, California.

*Colletes annae disseptus* Timberlake

*Colletes disseptus* Timblerlake, 1951, Wasmann J. Biol., vol. 9, p. 223.

A comparison of the male of *a. disseptus* with the type of *C. annae* convinces me that they are members of the same species, and that *disseptus* should rank as no more than a subspecies of *annae*. The three specimens of *disseptus* are from the coastal regions of California and the females are difficult to separate from *annae* on any character except color.

The pile of the metasomal terga of the males is lighter, almost white, and the testaceous rim of the metapleural prominence is slightly narrower than *annae*. However, Timberlake records a male from Conception Bay, Baja California, in which the pubescence is strongly tinged with yellow, much as in the males from Las Cruces, New Mexico, and Coahuila, Mexico. Genitalically the two forms are identical. The males of this subspecies differ from *a. annae* in having the wings dusky hyaline with close darker pubescence over the surface; the antennae are deep brownish-black and nervures dark brown.

The female is much as the male with integument deep black, the pile more strongly tinged with ochreus and with the basal fascia of the second metasomal tergum absent.

*Distribution:* One female, Riverside, California, October 9, 1948 (P. W. Weber) (holotype); Los Angeles County (Coquillett) (allotype); one male, Turlock, California, August 1950, has been recorded as *disseptus* by Timberlake, while another male from Conception Bay, Baja California, October 25, 1941, was placed with the species provisionally. The species is distributed along the coast of California and Baja California. The eastern limit of this subspecies is still unknown but it probably intergrades with *a. annae* in southeastern California.

The holotype from Riverside, California, is in the collection of the Citrus Experiment Station, Riverside, California, and the allotype from Los Angeles County, California, is in the collection of the University of Nebraska.

## *Colletes laticinctus* Timberlake

(Fig. 50)

*Colletes laticinctus* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 220.

The species was described from a series of females taken in New Mexico, Arizona, and Idaho. Additional material from the Swenk collection compared with the paratypes shows the synonymy between this species and a Swenk manuscript species named after the plant *Gutierrezia.* Many specimens, labeled as partypes, were distributed by Swenk. It is a sibling species to *annae* Cockerell and can be distinguished only with difficulty from that species. The males differ from *annae* in having the pile of the body light tawny, in having the disc of the second metasomal tergum just appreciably more sparsely folliculated, and in having the seventh ventral plates broadly rounded apically rather than abruptly truncated as in *annae.* The females closely resemble *annae* except that the precoxal spines are rudimentary. (In *annae* the spines are approximately twice as long as wide.) It is also similar to *americanus* and *mandibularis* but can most readily be distinguished by the short precoxal spines and the very narrow rims to the metapleural prominences, the rims being black in *laticinctus* and broadly testaceous in the other two species.

*Male:* length 8 mm., wing length 5.5 mm.

Pile of face dense and long, completely concealing clypeus, subantennal and supra-antennal areas, tinged with light yellow above; vertex with pile light, yellowish, and sparse, concentrated principally in ocellar triangle; upper genal areas with pile short, dense, and tinged with light yellow, pile becoming very long, fine, and white below with a very narrow, appressed rim immediately posterior to each compound eye; mesoscutum with pile long, dense, and tinged with yellow; scutellum with a very dense fringe of long, light ochreus pile about lateral and posterior margins; mesepisterna with pile long, fine, and pale grey to white, partially concealing surface; propodeum with long fringes of pale grey pile on lateroposterior margins, particularly dorsal surface, lateral and posterior faces with abundant, long, erect, pale grey pile; first metasomal tergum with apical fascia very dense, long, and weakly tinged with yellow, lateral fringes of pile long, dense, and fusing with apical fascia, pile of disc very long, dense, and tinged with yellow, partially concealing surface; metasomal terga two to five with fasciae broad, dense, and very weakly tinged with light yellow; second metasomal tergum with a weak basal fascia; metasomal terga three to six with discs having

abundant, short, erect to semierect, whitish pile; metasomal sterna two to four with dense, long apical fringes of pile, these apical fasciae broad and pale grey to tinged with light yellow.

Antennae reddish brown, long, flagellar segments one and one-half times as long as broad; malar spaces one-half as long as broad; clypeus short, convex, very finely and densely punctate over basal three fourths, apex with punctures sparser and tending to be weakly striate laterally, with shiny interspaces; vertex dull, finely and densely punctate. Prothoracic spines very short and sharp; mesoscutum densely punctate with shiny interspaces, punctures one-half to one puncture width apart on anterior and lateral faces, impunctate area large; scutellum with extreme lateral and posterior margins finely, densely, contiguously punctate, disc with punctures more distinct and separated by broad shiny interspaces, punctures one-half to one puncture width apart, anterior one third shiny, impunctate; mesepisterna closely punctate, punctures no more than one-half puncture width apart with shiny interspaces; metapleural prominences abrupt with very narrow, hyaline rims; propodeum with basal area sloping sharply ventrally, obscurely and irregularly pitted, pits not at all uniformly quadrate and very shallow, lateral and posterior faces moderately shiny and obscurely punctate, weakly roughened on lateroposterior margins; tegulae very light hyaline brown; wings whitish hyaline with a sparse covering of very short, whitish pile, nervures very light brown hyaline; legs brown basally, becoming a very light brown apically, ends of tibiae and also tarsi light brown; posterior basitarsi four times as long as broad. First metasomal tergum shiny, sparsely and finely punctate, punctures one to two puncture widths apart laterally, becoming much sparser and shallower medially; second metasomal tergum rather densely folliculated or very finely punctate, with follicles close, no more than one puncture width apart, especially medially; apical fascial depressions on metasomal terga one to five light brownish hyaline; second metasomal tergum weakly depressed basally; metasomal sterna shiny, rather densely and finely folliculated over posterior one third of each sternum; seventh ventral plates much as in *annae*, however with apical margins broadly rounded and membranous (fig. 50).

*Female:* length 9.5 mm., wing length 6 mm.

Pile of face short and dense about antennal bases and lower inner orbital margins; clypeus with a weak covering of short, pale grey

pile; vertex with abundant, erect pile tinged with light ochreus, concentrated principally in ocellar triangle; upper genal areas with pile dense, short, and tinged with ochreus, becoming much longer, finer, and whiter below, a broad band of appressed, white pubescence immediately posterior to each compound eye; mesoscutum densely covered with abundant, short pile tinged with yellowish; scutellum with a broad lateral and posterior band of short, plumose pile, strongly tinged with yellowish; mesepisterna with abundant, fine, pale grey to white pile, tinged with light yellow above, becoming pure white below, obscuring surface; propodeum with long fringes of pile tinged with light yellow along lateroposterior margins, longest and most dense above, lateral faces virtually bare, posterior face with abundant, erect, pale grey pile; pile of anterior two pairs of legs sparse and white to tinged with yellow, pile of posterior legs long, plumose, and tinged with light ochreus; first metasomal tergum with apical fascia broad, dense, and white, lateral fringes of white pile dense and extending to apical fascia, disc with abundant, erect, pale grey pile, partially concealing surface; metasomal terga two to four with fasciae very broad, dense, and white; second and third metasomal terga with broad, dense basal fasciae of pure white pile; metasomal sterna two to four with apical fringes of short, weak, pale grey pile, narrowed medially.

Antennae reddish brown, short, flagellar segments three-fourths as long as broad; malar spaces one-eighth as long as broad; clypeus convex, short, rather coarsely, striately punctate to apex, interspaces linear and shiny; vertex very shallowly punctate with shiny interspaces, punctures exceedingly fine; fascial foveae shallow, impunctate, extending above inner orbital margins and over one third of way to lateral ocelli. Prothoracic spines very short, roughly triangular; mesoscutum finely and distinctly punctate, punctures very close, less than one-half puncture width apart on anterior faces, punctures becoming coarser and sparser posteriorly to median discal area, impunctate area large; scutellum very densely, contiguously punctate on extreme lateroposterior margins, disc with punctures distinct and separated by shiny interspaces, punctures one-half puncture width apart, anterior one third shiny, impunctate; mesepisterna finely and densely punctate, punctures almost contiguous with linear interspaces, surface rather dull; metapleural prominences weak with very narrow, hyaline rims, rims just barely visible from above; propodeum with basal area sharply sloping ventrally, very

shallowly, obscurely pitted, pits hardly quadrate, lateral and posterior faces shiny, posterior face finely and sparsely punctate; tegulae very light hyaline; wings whitish hyaline with extremely short, light fulvous to tawny pile apically, nervures light brown; precoxal spines rudimentary; legs brown; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, virtually impunctate, a few, exceedingly fine punctures evident on lateroapical margins of disc; second metasomal tergum very finely and rather densely folliculated, apical fascial depression broad and light brownish hyaline; metasomal sterna coarsely and densely, uniformly folliculated, apical margins of sterna two to five with a very narrow, hyaline rim.

*Distribution:* One female, near Tecalote, New Mexico, September 5, 1930 (P. H. Timberlake) (holotype) on *Pectis papposa;* neallotype, male, Glen Sioux County, Nebraska, 4000 feet, August 20, 1906 (L. Bruner); 3 females, near Rowe, New Mexico, September 5, 1930 (P. H. Timberlake) (paratypes) on *Gutierrezia sarothrae;* 1 female, Huachuca Mountains, Arizona, September 11, 1928 (E. R. Leech) (paratype); 1 female, Grand Canyon, Arizona, August 19, 1939 (E. C. Van Dyke) (paratype); 1 female, Blackfoot, Idaho, September 5, 1932 (Louise Ireland) (paratype); 1 female, Sandia Mountains, New Mexico, 5000 feet, August 13, 1935 (C. D. Michener) (paratype).

Others: 2 males and 1 female, Glen Sioux County, Nebraska, 4000 feet, August 18, 1906 (M. H. Swenk) on *Gutierrezia sarothrae;* 2 males, 1 female, Glen Sioux County, Nebraska, 4000 feet, August 20, 1906 (L. Bruner); 1 female, Crawford, Nebraska, September 13, 1911 (J. T. Zimmer) on *Gutierrezia sarothrae;* 1 male, Lingle, Wyoming, August 10, 1949 (Dreisbach and Schwab); 1 female, Niobrara County, Wyoming, September 1, 1943 (Pfadt and Seaton); 3 males, Conant, Idaho, September 2, 1925, 4400 feet (R. W. Haegele) on *Gutierrezia sarothrae;* 1 male, Delle, Utah, August 21, 1931 (G. F. Knowlton); 1 male, Boulder, Colorado, August 24, 1900 (S. A. Rohwer) on *Polygonum;* 1 male, Magdalena Mountains, New Mexico, August, 1894 (F. H. Snow); 1 male, 45 miles east of Rock Springs, Wyoming, 7000 feet, August 5, 1934 (H. A. Scullen).

The holotype is in the collections of the Citrus Experiment Station, Riverside, California. The neallotype is in the collections of the University of Nebraska.

## *Colletes tectiventris* Timberlake

(Fig. 37)

*Colletes tectiventris* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 218.

This is a sibling species to *ochraceus* and is found principally in the desert regions of southern California but occurs as far north as Antioch. Both sexes are smaller than *ochraceus,* have the wings more whitish hyaline and the pile of the body paler, almost grey. The females have the metasomal terga completely covered with appressed pubescence and the rims of the metapleural prominences very narrow and brown to black. More difficulty may be encountered separating *tectiventris* from *annae* than from *ochraceus* but the propodeal characteristic cited in the key appears to be consistent.

*Male:* length 7-8 mm., wing length 5-5½ mm.

Pile of face dense and pure white, most dense about antennal bases and along inner orbital margins; upper clypeus with dense white hair on basal half, becoming suddenly sparse towards apex; hair of vertex pale grey, concentrated principally in ocellar triangle and upper genal areas, hair of lateral and lower genal areas pure white and long; pile of mesoscutum pale grey and sparse; scutellum with heavy fringe of pale grey pile about lateral and posterior edges; mesepisterna with long, pale grey to white pubescence, becoming whiter towards lower faces; lateral faces of propodeum with long, erect hair; first metasomal tergum with few, long, pale grey hairs on disc, becoming more dense toward basal area but never sufficiently dense to obscure the surface, tergum with dense fringes of hair laterally; metasomal terga two to five with fasciae of long, loose hair, very wide and almost pure white; sternal fasciae white composed of apical fringes of long pile; femora with long, loose, white pile, tibiae and tarsi with short, sparse pile, tending towards ochreus.

Antennae long, flagellar segments at least one and one-half times as long as wide, dark brown tending to black basally; malar spaces one-third to one-half as long as wide; clypeus short with shallow, elongate punctures over surface, interspaces shiny. Prothoracic spines absent; mesoscutum shiny, punctures about one puncture width apart on surface, becoming more widely separated about small impunctate area of mesoscutum; scutellum shiny anteriorly with a few deep punctures; mesepisterna shiny below with deep, almost contiguous punctures, becoming shallower and more crowded on upper and posterior edges, surface becoming duller

with increased crowding of punctures; metapleural prominences large with wide hyaline rims; lateral faces of propodeum shiny and weakly rugose, becoming dull and roughened towards dorsal and posterior surfaces, lateroposterior edges of propodeum rounded, basal area with indistinct, quadrate pits, abruptly sloping behind scutellum; tegulae testaceous with darkened areas at base, wings whitish hyaline with virtually no pubescence, nervures light brown except for subcosta-radius which is dark brown; legs black to dark brown at bases, tending to ochreus apically. First metasomal tergum impunctate with a few, fine, scattered follicles on the surface becoming indistinguishable towards mid line, disc shiny; second to fifth metasomal discs slightly folliculated over surface, surfaces very shiny, black; seventh ventral plates much as in *ochraceus* but discs more quadrate (fig. 37).

*Female:* length 9.5 mm., wing length 6.25 mm.

Pile of body short and plumose; pile of face white to pale yellow, clumped along inner orbital margins and about antennal bases; clypeus with a few ochreus hairs not obscuring the surface; vertex with yellowish-grey pile concentrated in the ocellar triangle; genal areas with appresssed pile on upper surface, extending laterally immediately behind the eyes, lower genal areas with long, loose, erect pile; mesoscutum covered with yellow to ochreus, short, dense pile; scutellum with abundant, longer pile clumped on posterior margin extending laterally to mesoscutum; yellowish pile of mesocutum extending laterally to the posterior lobe of pronotum and upper surface of mesopleura; pile of lower mesepisterna long, loose, pale grey to white; metasomal terga completely covered with ochreus-yellow, appressed pubescence, which may be worn from surface of some specimens; first metasomal disc with erect pile on anterior face, but completely appressed apically; metasomal terga two to five completely covered with ochreus pubescence; sixth metasomal tergum with deep ferrugineous pile (not appressed); metasomal tergal fasciae distinguishable as denser mats of pubescence; sternal fasciae absent; pile of anterior two pairs of legs short, white to ochreus in color, that of posterior femora and tibiae long and curled, hind basitarsi with a number of long, erect hairs.

Antennae short, dark brown, becoming darker basally; malar spaces one-fourth as long as wide; clypeus convex covered with elongate punctures to apex; vertex shiny and very sparsely punctate. Prothoracic spines long and sharp, directed more dorsally than later-

ally; mesoscutum deeply punctate with close contiguous punctures anteriorly, punctures becoming larger, deeper, and separated by shiny interpunctate areas towards ends of the parapsidal lines, impunctate area shiny and small; scutellum with anterior half shiny impunctate; mesepisterna dull, densely punctate with close, contiguous, shallow punctures, becoming closer and finer towards upper and posterior surfaces; metapleural prominences relatively weak, rimmed with very narrow, dark brown rims, not sharply concave beneath; lateral faces of propodeum shiny, smooth, basal area of propodeum with shallow, quadrate pits, posterior face of propodeum closely but weakly transversed by weak rugae, giving it a dull, roughened appearance, lateroposterior edge demarked by a very weak ridge, not sharply rounded; wings with short, ochreus pubescence very abundant on apical membranes, becoming sparser toward the base, nervures light brown, membrane whitish hyaline, tegulae ochreus hyaline, darker brown at base; legs dark brown to black at base, becoming lighter apically; hind basitarsi 3.5 times as long as wide. Metasomal terga one to four with discs shiny and virtually impunctate beneath pubescent covering; apical bands of metasomal terga reddish brown compared with the shiny blackness of the discal surface.

*Distribution:* One female, Victorville, California, September 28, 1938 (Timberlake) on *Isocoma acradenia;* 2 males, 2 females, Oro Grande, California, September 14, 1935 (Timberlake) on *Isocoma acradenia;* 5 males, 8 females, Oro Grande, California, September 14, 1935 (C. D. Michener) on *Isocoma;* Antioch, California, August 9, 1936 (C. D. Michener) on *Eriogonum.*

The holotype from Victorville, California, is in the collections of the Citrus Experiment Station, Riverside, California.

### *Colletes bradleyi* Mitchell

*Colletes bradleyi* Mitchell, 1951, J. Elisha Mitchell Sci. Soc., vol. 67, p. 239.

This species, known from two females, appears to be a close ally of *americanus.* A more concise opinion on its position will require the collection and examination of the male.

*Female:* length 9 mm., wing length 6.25 mm.

Pile of face sparse and white, a few, sparse, finer hairs on clypeus, not at all concealing surface; vertex with pile tinged with fuscous, dense in ocellar triangle; upper genal areas with pile sparse and white, pile becoming longer and denser below; mesoscutum with a sparse covering of pile tinged with yellow; scutellum with a broad

lateral and posterior rim of dusky yellowish to light ochreus pile; mesepisterna with pile long, fine, and pale grey; propodeum with long fringes of light yellowish pile along lateroposterior margins, fringes longest and most dense on dorsal surface, lateral faces with a few overhanging hairs from metapleural propodeal margin, posterior face with abundant, erect, pale grey pile; pile of anterior two pairs of legs short and white to tinged with yellow, posterior legs with pile long, dense, and tinged with yellow; first metasomal tergum with apical fascia weak and narrow, often interrupted medially, pubescence dusky, lateral fringes of pile weak, becoming short and barely reaching apical fascia, disc with a few, scattered, light hairs; metasomal terga two to five with apical fasciae broader, denser, and dusky to tinged with fuscous; metasomal terga three to six with discs having abundant, erect, pale grey to fuscous pile; metasomal sterna having abundant, short, erect, fuscous pile, weakly scopiform.

Antennae reddish brown to black above, flagellar segments about as long as broad; malar spaces very short, one-fourth as long as broad; clypeus short, weakly convex, tending to be flattened medially, densely punctate to apex, punctures round to weakly striate; vertex shiny, tending to impunctate; fascial foveae rather indistinct, weakly rounded dorsally and extending slightly above inner margins of compound eyes. Prothoracic spines short and blunt, roughly triangular; mesoscutum shallowly punctate, punctures at least one puncture width apart about anterior and lateral margins, impunctate area small; scutellum densely, obscurely punctate over posterior one third and lateral margins, punctures becoming more distinct and shallower on median discal area, anterior edge shiny, impunctate; mesepisterna coarsely and shallowly punctate, punctures about one puncture width apart with shiny interspaces; metapleural prominence strong with a broad testaceous rim, abruptly declivous beneath; propodeum with basal area broad, sloping rather sharply ventrally and irregularly pitted, lateral faces shiny, posterior face shiny with numerous rugae forming irregular pits outside of triangle; tegulae light hyaline brown; wings dusky with abundant, very light fuscous pile, nervures brown; legs brown, becoming somewhat blacker basally; precoxal spines short to absent; posterior basitarsi three and one-half times as long as broad. First metasomal tergum shiny, very finely and sparsely folliculated laterally, follicles becoming sparser on median surfaces where they may be three to six follicle widths apart; second metasomal tergum densely and finely folliculated, surface shiny; metasomal sterna two to five dull, very densely and coarsely folliculated.

*Distribution:* Chatsworth, Burlington County, New Jersey, June 15, 1923 (J. C. Bradley) (holotype); Chesilhurst, New Jersey, June 3, 1939 (H. K. Townes) (paratype).

The type is in the Cornell University collections.

*Colletes mitchelli* sp. nov.

(Fig. 38)

This is a sibling species to *americanus* and can be separated from the latter only with difficulty. The metapleural prominences of the male have the testaceous rims much narrower and the seventh ventral plates have the lateral extensions of the discs much reduced, making them roughly square; the pile covering of the plates is concentrated principally on the basal medial portion of each disc. The female differs from *americanus* in having the testaceous rim of each metapleural prominence absent, the rim evident only as a weak, black margin. The species is very sparsely distributed over America east of the Great Plains.

*Male:* length 9 mm., wing length 6.25 mm.

Pile of face erect, dense, and tinged with tawny, concealing antennal bases and upper clypeus, a weak fringe of appressed pubescence along inner orbital margins; vertex with pile sparse and tinged with light ochreus, most dense in ocellar triangle; upper genal areas with pile short and tinged with grey, becoming longer, finer, and pure white below; mesoscutum with pile long, erect, and pale grey, concentrated principally on anterior one half; scutellum with a fringe of long, pale grey pile about lateral and posterior margins, discal area bare; mesepisterna with pile long, fine, and dense, dusky to pale grey above, becoming white below; propodeum with fringes of long, pale grey pile on lateroposterior margins, most dense on extreme upper faces, lateral and posterior faces with sparse, erect, pale grey hairs; pile of legs rather long and fringelike on femora, white to pale grey, pile of tibiae and tarsi shorter, sparser, and pale grey; first metasomal tergum with apical fascia broad, dense, and white, lateral fringes of pile rather dense, particularly on anterolateral faces, fringes reaching apical fascia, disc with abundant, erect, pale grey pile; metasomal terga two to four with fasciae broad, very weak, and white, often broadly interrupted probably due to wear; metasomal terga three to six with discs having sparse, short, erect, dusky to light fuscous pile, not at all concealing surface; metasomal sterna two to four wth very narrow apical fringes of pale grey pile.

Antennae long, reddish brown, flagellar segments one and one-

third times as long as broad; malar spaces very short, approximately one-fourth as long as broad; clypeus convex and short, densely and finely punctate over entire surface, interspaces linear and shiny; vertex dull, very finely and rather densely punctate. Prothoracic spines very short and sharp; mesoscutum finely and rather sparsely punctate, punctures at least one puncture width apart on anterior one-half and lateral faces, becoming much sparser medially, impunctate area large; scutellum densely, contiguously punctate on extreme lateral and posterior faces, discal area sparsely punctate with punctures one to two puncture widths apart, anterior one third shiny, impunctate; mesepisterna densely punctate, punctures one-half puncture width apart with shiny interspaces; metapleural prominences abrupt with very narrow, deep hyaline rims, rims very much narrower than in typical *americanus*; propodeum with basal area shallowly and broadly quadrately pitted at median surfaces, pits becoming irregular and obscure laterally, lateral and posterior faces shiny and sparsely punctate; tegulae light hyaline brown; wings dusky with abundant, deep fuscous pubescence, nervures brown; legs with coxae, femora, and tibiae deep brown to black, tarsi brown; posterior basitarsi five times as long as broad. First metasomal tergum shiny, very finely folliculated, virtually impunctate, follicles becoming denser and more conspicuous laterally; second metasomal tergum shiny, rather densely folliculated, much more so than first tergum, very shallowly depressed basally; metasomal terga one to five with apical fasciae in shiny, light brownish hyaline depressions; metasomal sterna shiny, sparsely and finely folliculated; seventh ventral plates with disc area almost square, a very dense and long hair band over basal one half and a very narrow, lateral, nonpubescent rim to each disc (fig. 38).

*Female:* length 10 mm., wing length 6.5 mm.

Pile of face sparse, erect, and tinged with yellow, particularly about antennal bases and inner orbital margins; vertex with pile strongly tinged with light ochreus, concentrated principally in ocellar triangle; upper genal areas with pile tinged with ochreus, pile becoming finer and slightly longer below, tawny; mesoscutum with pile tinged with ochreus, short, and concentrated principally over anterior half, lateral and posterior margins; scutellum with a broad lateral and posterior fringe of ochreus pile; mesepisterna with the pile long, fine, tinged with ochreus above, becoming white below; propodeum with long fringes of light ochreus pile on latero-posterior margins, longest and most dense above, becoming finer,

sparser toward pedicel, lateral and posterior faces with sparse covering of erect, pale grey to light ochreus pile; anterior two pairs of legs with pile sparse, rather long, and pale grey, posterior pair of legs with pile long, plumose, and tinged with ochreus; first metasomal tergum with apical fascia of light ochreus pubescence, fascia broadened laterally and interrupted medially probably due to wear, lateral fringes of light ochreus pile, longest and most dense on anterolateral margin, lateral fringes barely reaching apical fascia, disc with abundant, erect pile on extreme anterior face, pile becoming somewhat appressed on anterolateral portions of the disc; metasomal terga two to four with fasciae broad, weak, and tinged with yellowish, fasciae may be interrupted due to wearing; second metasomal tergum with a broad, weak basal fascia tinged with yellow; metasomal terga three to five with discal areas having sparse covering of erect, pale grey pile; metasomal sterna with a few, scattered, pale grey hairs.

Antennae brown, short, flagellar segments three-fourths as long as broad; malar spaces very narrow, one-fifth as long as broad; clypeus convex, very densely and striately punctate to apex, interspaces shiny; vertex dull, very finely and rather densely punctate; fascial foveae deep, broadened toward dorsal surface and narrowed again at extreme apex, apical portion of each fovea extending just barely above inner orbital margin and reaching but one third of way to lateral ocellus. Prothoracic spines very short and sharp; mesoscutum densely and deeply punctate over anterior, lateral, and posterior margins, punctures approximately one-half puncture width apart with shiny interspaces, becoming sparser toward median discal area, impunctate area large; scutellum very finely, densely, contiguously punctate about lateral and posterior margins, disc with scattered, coarse punctures, approximately one-half to one puncture width apart, anterior one third shiny, impunctate; mesepisterna densely, contiguously punctate and dull above, punctures becoming finer and sparser, especially on lower posterior faces; metapleural prominences weak, with very narrow, dark brown to black rims; propodeum with basal area shallowly, quadrately pitted medially, pits becoming irregular laterally, lateral and posterior faces shiny and finely punctate, weakly roughened; tegulae light hyaline brown; wings dusky with abundant, fuscous pubescence, nervures brown; legs deep brown; posterior basitarsi four times as long as broad; precoxal spines approximately one and one-half times as long as broad. First metasomal tergum shiny, very finely and sparsely follic-

ulated, principally on lateral and apical faces, follicles most dense on extreme lateral faces where they may be approximately one follicle width apart; metasomal tergum two with disc closely, finely folliculated, dull; metasomal sterna shiny, with sparse follicles.

*Distribution:* Holotype male, Virginia Beach, Virginia, September 30, 1932; allotype female, Virginia Beach, Virginia, October 6 (Fred Knab); paratypes: 1 male, Virginia Beach, Virginia, September 30, 1932; 3 males, Brigantine, New Jersey, September 9, 1927 (C. H. Ballou); 3 males, Sandy Hook, New Jersey; 1 male, Seaside Park, New Jersey, September 8 (Weiss and West); 2 males, Meredosia, Illinois, August 19, 1913, and August 22, 1917; 1 male, Illinois Sands (Hart Collection); 1 male, Pensacola, Florida, October 11-14, 1914; 3 males, Lee County, Texas, October, 1910 (A. Birkmann); 1 male, Ramsey Co., Minnesota, July 13, 1911; 1 female, West Point, Nebraska, September 6, 1912; 3 females, New River, North Carolina, November 20-30, 1944 (G. E. Bohart).

The species is named after Dr. T. B. Mitchell in recognition of his extensive studies on the bees.

The holotype and allotype are in the United States National Museum.

### *Colletes ochraceus* Swenk

(Fig. 39)

*Colletes ochraceus* Swenk, 1906, Canadian Ent., vol. 38, p. 42; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 217.

The male of this species closely resembles *americanus* Cresson; however, it can be distinguished from that species by the long malar spaces, which are about two-thirds as long as wide; the close, contiguous punctures of the mesepisternum, and the coarse, dense punctures on the first metasomal tergum. The female of *ochraceus* is readily distinguishable from *americanus* in having the metasomal terga completely covered by sparse, ochraceus, appressed pubescence, the pubescence occasionally tending to yellowish on basal terga.

*Male:* length 8-9 mm., wing length 5½-6 mm.

Pile of face dense, ochreus, concentrated principally about antennal bases and along lower inner orbital margins; clypeus with moderately dense, ochreus to yellow pile on basal half; upper face with sparse, deep ochreus pile; vertex and ocellar triangle with a few, scattered, yellow hairs; upper genal areas covered with moderately dense, light ochreus pile, becoming slightly appressed behind upper portion of compound eyes but much longer and looser

on lower surfaces; mesoscutum covered with deep ochreus to yellow pile; scutellum with few ochreus hairs, chiefly on lateral and posterior margins; mesepisterna with a few, long, pale grey hairs over surface, becoming deep ochreus above, particularly on posterior lobes of pronotum and upper mesepisterna; metapleura with sparse, pale grey pile below prominences; dorsolateral and posterolateral margins of propodeum with long fringes of light ochreus pile, extending from basal area to pedicel, posterior face with a few, long, pale grey hairs, becoming denser on anterior face, tergum with dense lateral fringes of short, light ochreus pile extending posteriorly to apical fascia; metasomal terga with fasciae weak and broad, easily removed by rubbing; discs of metasomal terga two to five with abundant, erect, pale grey pile, giving surface a pale grey sheen; metasomal sterna with broad, pale grey fasciae, slightly broadened medially.

Antennae very long, flagellar segments at least one and one-half times as long as wide; malar spaces two-thirds as long as wide; clypeus weakly convex, densely and contiguously punctate over entire surface, punctures contiguous on basal half giving surface dull appearance, punctures becoming slightly sparser and minutely striate on apical lateral margins; vertex dull, closely punctate. Prothoracic spines absent; mesoscutum with disc covered with coarse punctures, approximately one puncture width apart, interspaces shiny, impunctate area small; scutellum with posterior two thirds roughened and contiguously punctate, anterior one third shiny impunctate; mesepisternum densely, coarsely punctate, punctures on median discal area almost contiguous with very narrow interspaces, punctures above close and dense; metapleural prominences strongly protuberant with broad testaceous rims, broadest at posterior edge, sharply concave beneath; propodeum with lateral faces roughened and weakly striate, basal area with shallow quadrate pits, not sloping sharply behind, posterior face weakly striate and dull; tegulae dark ochreus to dark brown basally; wings dusky covered with sparse, short, ochreus pubescence, nervures dark brown, except for stigma which tends toward lighter brown; legs dark brown to black apically; posterior basitarsi five times as long as wide. First metasomal tergum with disc coarsely punctate particularly on lateral faces, punctures approximately one puncture width apart laterally, becoming sparse and obscure at mid line, interspaces shiny; metasomal terga two to four with discs deeply folliculated, follicles about one follicle width apart with shiny interspaces; metasomal tergal

fasciae in sharply depressed apical bands, depressions broad and light brownish hyaline; metasomal sterna with apical margins straight; seventh ventral plates with laterobasal margins weakly rounded (fig. 38).

*Female:* length 10-11 mm., wing length 6 mm.

Pile of face very dense and short about antennal bases and along inner orbital margins; clypeus with sparse covering of long, ochreus pile not obscuring surface; pile of face extending above antennal bases to vertex, becoming deep yellow above antennal bases; ocellar triangle and upper genal areas with dense, deep yellow pile; pile of occiput becoming light ochreus on lateral margins and appressed behind compound eyes, pile of lower genal areas light ochreus to pale grey; mesoscutum densely covered with light yellow pile; scutellum with abundant, deep yellow pile about lateral and posterior margins, with semiappressed pile on posterior surface directed forward to conceal surface; mesepisterna covered with very long, weakly plumose, ochreus pile, becoming more yellow on upper surfaces and upper portions of pronotum; metapleura with abundant pile on surfaces below prominences; propodeum with lateral faces having considerable appressed pile particularly at metapleural margin, posterior portion of lateral face bare, dorsolateral margin with dense fringe of deep ochreus pile, becoming much weaker on lateroposterior margin, posterior face with a few, scattered, long, ochreus hairs; anterior two pairs of legs with sparse, short, pale grey pile; posterior femora with long, sparse, apical, plumose hairs; tibiae with pile pale grey to ochreus and very dense; metasomal terga completely covered with deep ochreus to yellow pubescence, completely concealing surface of metasomal terga one to four, fasciae discernible as denser layers of yellow pubescence; first metasomal tergum with abundant erect pile on anterior face and semierect lateral fringes extending posterior to fascia; metasomal terga five and six with at least some of discal area free of appressed pubescence; metasomal tergum six having disc covered with semierect, ferrugineous pile; metasomal sterna with weak fringes of pale grey pile on apical margins of each sternum.

Antennae short, dark brown to black; malar spaces one-fourth as long as wide; clypeus weakly convex and deeply, densely striately punctured, interspaces shiny; vertex dull, punctate. Prothoracic spines short and sharp; mesoscutum with disc closely, deeply, and contiguously punctate, except for a small impunctate area; scutellum with posterior three-fourths deeply punctate and dull, anterior one

fourth shiny impunctate; mesepisternum dull, deeply contiguously punctate over entire surface; metapleural prominences greatly protuberant with broad testaceous rims, abruptly concave beneath; propodeum with lateral faces shiny, basal area with shallow quadrate pits, posterior surface shiny and weakly roughened; tegulae dark brown hyaline; wings dusky covered with short, ochreus pubescence, nervures brown; legs dark brown to black apically; posterior basitarsi five times as long as wide. Metasomal terga one to four with surface shiny impunctate.

*Distribution:* Antioch, California, September 6, 1936 (G. E. Bohart); San Quentin, Baja California, August 2, 1938 (Michelbacher and Ross); 20 miles west San Augustine, Baja California, September 24, 1941 (Ross and Bohart) on *Eriogonum;* 31 miles north of Encenda, Baja California, August 1, 1934 (Timberlake) on *Isocoma vernonioides.*

The single specimen examined from Antioch gives evidence that the female does not have the deep yellow pubescence common to those in Lower California. The appressed pubescence of the metasomal terga does not appear to be complete for on terga one to four there is a narrow, non-pubescent area just anterior to the metasomal fasciae.

The holotype from "Southern California" is in the collection of the University of Nebraska.

### *Colletes gypsicolens* Cockerell

(Fig. 40)

*Colletes gypsicolens* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 47; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 23; 1898, Bull. Denison Univ., vol. 11, p. 43; 1898, Bull. Univ. New Mexico, vol. 1, p. 43; 1905, Psyche, vol. 12, p. 86; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 400; 1951, Wasmann J. Biol., vol. 9, p. 217.

The species originally described from New Mexico occurs in abundance in California, Utah, and northward as far as the valleys of British Columbia. It is a member of the *americanus* group, but the metapleural prominences are very weak having very narrow black rims that may often be overlooked. The body is densely covered with long, white pile, which completely obscures the head, thorax, and the first metasomal tergum. The malar spaces are long for the *americanus* group, being as long as broad in the male and one-half as long as broad in the female. The first metasomal tergum is shiny, impunctate.

*Male:* length 10.5 mm., wing length 6.25 mm.

Pile of face very dense, long, and pure white to a line well above antennal bases; vertex with pile long, dense, and pale grey, concentrated principally in ocellar triangular region; genal areas with pile long, dense, and white, becoming much longer and more dense below, completely obscuring surface; mesoscutum with pile pale grey, long, and partially obscuring surface; scutellum with pile very long, white, and dense about peripheral margins, pile overhanging and partially concealing discal area; mesepisterna with pile very long, fine, dense, and white, obscuring surface; propodeum with lateral and lateroposterior faces densely covered with long, white pile, posterior face with pile sparser and shorter; pile of legs long, white, and dense, particularly on femora; first metasomal tergum with apical fascia very broad, dense, and white, lateral fringes of white pile dense and extending to apical fascia, discal area with abundant, long, erect, white pile, partially obscuring surface; metasomal terga two to five with fasciae very broad, dense, and pure white; metasomal terga three to six with discs having abundant, erect, tawny pile, pile long; metasomal sterna two to four with dense apical fringes of white pile.

Antennae long, deep brown to black, flagellar segments one and one-half to one and three-fourths times as long as broad; malar spaces as long as broad; clypeus convex, finely and densely punctate about frontoclypeal margins and basal two thirds, punctures becoming sparser and tending to be weakly striate at apex; vertex finely and rather densely punctate with narrow, shiny interspaces. Prothoracic spines very short and sharp; mesoscutum densely punctate about anterior and lateral margins, punctures no more than one-half puncture width apart, becoming sparser medially, impunctate area very small; scutellum strongly convex, finely and densely punctate, contiguous on extreme lateral and posterior margins, separated by one-half puncture width on posterior half, punctures becoming progressively sparser toward anterior face, which is shiny, impunctate; mesepisterna very finely and densely punctate with shiny, linear interspaces; metapleura weakly protuberant above with very narrow, deep brown to black rims; propodeum with the basal area very shallowly, quadrately pitted, lateral and posterior faces shiny, posterior face particularly very weakly punctate; tegulae light hyaline brown; wings tending to whitish hyaline with a sparse covering of very short, tawny pubescence, nervures light brown; legs brown to brownish black basally; posterior basitarsi long and slender, approximately

five times as long as broad. First metasomal tergum shiny, impunctate, with a few, fine, sparse follicles on median discal area, punctures becoming evident on extreme lateral faces where they are very shallow and approximately one to two puncture widths apart; second metasomal tergum finely folliculated with shiny interspaces; metasomal sterna shiny, finely and sparsely folliculated; seventh ventral plates much as in *mandibularis,* however larger and with but median and lateral patches of fulvous pubescence, median discal area is non-pubescent hyaline, median and lateral margins strongly reflexed (fig. 40).

*Female:* length 12 mm., wing length 7.25 mm.

Pile of face long, dense, and pale grey, particularly about antennal bases and inner orbital margins; clypeus sparsely covered with erect, pale grey pile; vertex with pile long and dense, tinged with ochreus particularly in ocellar triangle; upper genal areas with pile dense and tinged with light yellow, pile becoming much longer, finer, and whiter below, a narrow rim of appressed pubescence immediately posterior to each compound eye; mesoscutum densely covered with long, erect, pale grey pile, obscuring surface; scutellum with a long fringe of pale grey pile about lateral and posterior margins, pile tending to overhang discal area; mesepisterna with a dense covering of long, pale grey to pure white pile; anterior two pairs of legs with pile sparse, long, white to pale grey; posterior pair of legs with pile long, plumose, and dense, pale grey to tinged with light ochreus; propodeum with long fringes of pale grey pile along lateroposterior margins, posterior face with sparse covering of erect, pale grey pile; first metasomal tergum with apical fascia broad, dense, and white, lateral fringes of white pile extending to apical fascia, disc with abundant, erect, white pile partially concealing surface; metasomal terga two to five with fasciae very broad, dense, and pure white; second metasomal tergum with a broad, white basal fascia; metasomal sterna two to four with apical fringes of long, pale grey pile.

Antennae brown to black, flagellar segments barely longer than broad; malar spaces three-eighths as long as broad; clypeus convex, rather coarsely and densely striately punctate with shiny linear interspaces; vertex shiny, finely punctate; ocular areas weakly depressed, almost obscure on dorsomedian margins. Prothoracic spines very short and sharp; mesoscutum densely and rather coarsely punctate, punctures no more than one puncture width apart, except on median discal area, impunctate area absent; scutellum finely, densely con-

tiguously punctate about lateral and posterior margins, posterior portion of disc with punctures about one-half puncture width apart with shiny interspaces, anterior one third shiny impunctate; mesepisterna densely punctate with punctures no more than one-half puncture width apart, interspaces shiny; metapleura weakly protuberant above with very narrow, brown rims; propodeum with basal area shallowly pitted, lateral and posterior faces shiny, posterior face weakly and sparsely punctate; tegulae light hyaline brown; wings weakly covered with dusky pubescence, nervures brown; legs deep brown to black, posterior basitarsi long and slender, approximately five times as long as broad. First metasomal tergum shiny, impunctate; second metasomal tergum very finely and sparsely folliculated, surface shiny; metasomal sterna shiny, coarsely and sparsely folliculated, with broad, shiny interspaces; extreme apical margin of terga two to five light hyaline brown.

*Distribution:* New Mexico: Albuquerque; Embudo; White Sands. Arizona: Grand Canyon. Utah: Kelton; Grand Gulch; Wolf Creek Pass, Skull Valley; Clearfield; Promontory. Colorado: Great Sand Dunes National Monument; Gardner. Nevada: Austin; Carlin. California: 9 miles south Victorville; Mill Creek, San Bernardino County; Oro Grande; Chimney Meadows, Tulare County; Phelam; Upper Santa Anna River, San Bernardino County. Oregon: Rufus, Sherman County. Washington: Yakima. British Columbia: Oliver; Summerland; Okanagan; Penticton; Vernon.

*Flight records:* This is an autumnal species, having been recorded between August 23 and November 1. The species is most abundant in late September and throughout the month of October.

*Plant records: Aster, Chrysothamnus nauseosus.*

Timberlake also records the species as visiting *Isocoma veneta* var. *vernonioides.*

The holotype was last recorded in the Cockerell collection; however, efforts to locate the specimen have proved futile. The type data are "White Sand by Whitewater, New Mexico, taken on *Bigelovia,* Oct. 6 (C. H. Townsend C36)". One specimen in the Timberlake collection bears only the label "C36" and may well be one of the four males of the type series.

## *Colletes albescens* Cresson

(Fig. 41)

*Colletes albescens* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 168; 1872, Trans. Amer. Ent. Soc., vol. 4, p. 249; Bridwell, 1899, Trans. Kansas Acad. Sci., vol. 16, p. 209; Robertson, 1904, Canadian Ent., vol. 36, p. 276; 1914, Ent. News, vol. 25, p. 73; Cresson, 1916, Mem. Amer. Ent. Soc., no. 1, p. 106; Robertson, 1926, Ecology, vol. 7, p. 378; 1928, Flowers and Insects, p. 10; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301.

This species has often been confused with *aberrans* although the two are readily distinguishable. The long malar spaces in both sexes, half as long as broad in the female, and as long as broad in the male, separate *albescens* from the majority of species in the group.

*Male:* length 9.5 mm., wing length 6 mm.

Pile of face most dense along the inner orbital margins; clypeus with pile sparse and white; vertex with a few pale grey hairs, particularly in the ocellar triangle; upper genal areas with a few, scattered, pale grey hairs becoming more dense, longer, and whiter towards lower portion; mesoscutum with abundant, erect, plumose, pale grey pubescence; scutellum with moderate amount of long, loose pile about peripheral margins, not much denser than that of disc of mesoscutum; mesopleura with loose, plumose pubescence not concealing surface; propodeum with lateral faces covered with a weak covering of white, semiappressed pubescence becoming longer toward lateroposterior and laterodorsal margins where fringes of long hair follow margins from basal area halfway down to pedicel, posterior face with very long, plumose pile; legs with weak covering of long, pale grey pile on femora, pile of tibiae and tarsi short, pale grey to ochreus; first metasomal tergum sparsely covered with a few, erect, white hairs becoming semiappressed but never concealing surface of dorsal surface of disc, lateral fringe of long, white pile extending to apical fascia; metasomal fasciae narrow and weak, easily removed by rubbing; second metasomal tergum with weak basal fascia of a few white hairs; discs of terga two to five covered with short, ochreus, semierect pile giving a sheen to surface; sternal fasciae complete, expanding slightly medially.

Antennae dark brown to black, flagellar segments slightly longer than broad; malar spaces as long as wide; clypeus weakly convex, slightly flattened medially but not furrowed, with sparse, fine, round punctures basally, extending down the centre of clypeus, leaving lateral portions of apex relatively free of punctures; vertex shiny black with a few fine punctures. Prothoracic spines absent;

mesoscutum with coarse, dense punctures, approximately one puncture width apart, interspaces shiny, impunctate area large, punctures on extreme posterior surface very fine and dense, at least half the size of those on anterior part of mesoscutum; scutellum with deep, contiguous punctures behind, anterior face shiny impunctate; mesopleura shiny black, punctures deep and coarse, about one puncture width apart on lower surface, becoming shallower and denser on extreme upper surface; propodeum with lateral faces shiny with a few weak rugae towards posterior edges, lateral and posterior faces separated by a weak ridge extending from basal area to pedicel, posterior face weakly rugose, basal area with deep, quadrate pits, not sloping sharply posteriorly; tegulae deep brown hyaline; wings whitish hyaline with dark brown nervures; legs dark reddish brown; posterior basitarsi long and slender, at least five times as long as wide. First metasomal tergum shiny black with few fine punctures over surface, at least four puncture widths apart; second and third metasomal terga dark, shiny, and rather densely folliculated; apical fascial depressions becoming progressively wider from first to second to third metasomal terga, depressions ochreus compared with shiny black surface of disc; seventh ventral plates with weak rims of pubescence about basal and medio-basal portions of discs (fig. 41).

*Female:* length 10-11 mm., wing length 6 mm.

Pile of face sparse, concentrated principally along lower inner orbital margins; clypeus with a few, short, white hairs; vertex with a little pale grey pile in ocellar triangle; genal areas with whitish pile dorsally, becoming longer and white ventrally; mesoscutum with abundant pale grey hair on surface; scutellum with dense concentration of greyish pile about lateral and posterior edges; mesopleura covered with long, sparse, plumose hairs not concealing surface; propodeum with lateroposterior margins having fringes of long, white hair extending from basal area to pedicel, posterior face with a few, long, white hairs; legs with abundant, long, white pile on femora, hind legs with pile long, curved, and extremely plumose, tibiae and tarsi with short, dense, light ochreus pile; first metasomal tergum with weak anterolateral fringes extending part way to fascia, anterior face of disc with moderate scattering of long, white, erect pile, becoming appressed on anterior portion of dorsal face of disc; fasciae of short, white pubescence, becoming progressively wider from first to third metasomal terga; second metasomal ter-

gum with a broad basal fascia of short, white pile; discs of terga two to five with a few white hairs; metasomal tergum six with disc covered by abundant ochreus to light ferrugineous pile giving surface a deep golden appearance; sternal fasciae virtually absent, a few, short, ochreus hairs on extreme apical margins.

Antennae short, dark brown to black; malar spaces three-fourths as long as wide; clypeus weakly and uniformly convex, shiny, with a few, elongate, coarse punctures, punctures becoming sparser toward apex; fascial foveae deep and distinctly depressed; vertex dull and roughened. Prothoracic spines absent; mesoscutum shiny, black, with coarse, dense punctures on anterior surface, punctures less than one puncture width apart, impunctate area large; scutellum with coarse, deep punctures on posterior half; mesopleura dull, punctures coarse and deep, much larger below, becoming smaller and denser toward dorsal surface; metapleural prominences large with broad, testaceous rims; propodeum with lateral and posterior faces dull and weakly papillated, basal area with deep quadrate pits; legs dark brown to black basally, tending to brown apically; posterior basitarsi four times as long as wide with a shallow, longitudinal groove on posterior portion of dorsal surface; tegulae deep brown hyaline; wings whitish hyaline, covered with short, ochreus pubescence, especially at tip, nervures dark brown. First metasomal tergum virtually impunctate, shiny; second and third metasomal terga closely folliculated giving surface a dull appearance.

*Distribution: C. albescens* is found to occupy the more arid areas of the western great plains extending from New Mexico northward to Manitoba with the known eastern limit at Lake County, Illinois. The species also ranges westward to Utah. On the basis of the present data the species appears to be an oligotropic visitor on *Amorpha canescens,* but much needed collection data may prove otherwise.

Illinois: Lake County. Wisconsin: Prescott, Pierce County; St. Croix County; Burnett County. Manitoba: Aweme. South Dakota: Rosebud. Nebraska: Halsey; Crete. Kansas: State record. Colorado: Fort Garland. Utah: Goshen. New Mexico: Portales.

*Flight records:* June 28 to August 6.

*Plant records: Amorpha canescens.*

The holotype from Illinois is in the Academy of Natural Sciences of Philadelphia.

## *Colletes aberrans* Cockerell

(Fig. 42)

*Colletes aberrans* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 44; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 19; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; Graenicher, 1910, Bull. Pub. Mus. Milwaukee, vol. 1, p. 228; 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 404.

This species is easily distinguished from the rest of the *americanus* group by the peculiarity of the prothorax. The anterior edge of the pronotum is raised and protrudes as an erect plate, most evident as an abruptly protruding edge above the coxal bases. The prothoracic tergum is very broad with both the anterior and the posterior edges raised slightly to form a broad, weakly convex plate. In the more northerly limits of the range the pile of the female, in particular, becomes yellowish or almost ochreus. This is most evident in the Wisconsin and Medicine Hat specimens. A tinge of yellow is noticeable on specimens taken in western Kansas. It may well be that the age of the individual is a factor for the change from white to yellow. All records of nesting sites have been in or about sand dunes.

*Male:* length 9 mm., wing length 7.25 mm.

Pile of face long, dense, and pure white, concealing clypeus and antennal basal area up to median ocellus, pile weakly tinged with pale grey above antennal bases; vertex with pile pale grey to tinged with yellowish, pile concentrated principally in ocellar triangle; upper genal areas with pile short, pale grey, becoming much longer and finer below, a very narrow rim of appressed, whitish pile immediately posterior to each compound eye; mesoscutum very densely covered with abundant, short, pale grey to light yellow pile; scutellum with a long, broad fringe of pile about lateral and posterior margins, pile tinged with light yellow; mesepisterna with pile long, pale grey above, becoming whiter below; propodeum with dense fringes of long, dusky pile on lateroposterior margins, most dense on dorsal surfaces, lateral and posterior faces with abundant, erect, pale grey pile; pile of legs short and white; first metasomal tergum with apical fascia very broad, dense, and white, lateral fringes of long, white pile very dense to apical fascia, disc with abundant, erect, whitish pile, partially concealing surface; metasomal terga two to five with fasciae broad, dense, and pure white; metasomal terga four to six with sparse covering of short, erect, white pile; metasomal sterna two to four with broad apical bands of pale grey pile, bands slightly broadened medially.

Antennae long, reddish brown to black above, flagellar segments one and one-half times as long as broad; malar spaces one-half as long as broad; clypeus weakly convex, rather flattened medially, very finely and densely punctate over basal three fourths and along median line, extreme apicolateral faces with punctures sparser and weakly striate with shiny, linear interspaces; vertex finely and densely punctate with shiny interspaces. Prothoracic spines vestigial; mesoscutum finely punctate with shiny interspaces, punctures one-half puncture width apart along anterior and lateral faces, impunctate area small; scutellum strongly convex, densely punctate on extreme lateral and posterior edges, disc with punctures coarser and sparser, being one-half to one puncture width apart and having shiny interspaces, punctures extending almost to anterior face; mesepisterna distinctly punctate with punctures about size of those on mesoscutum, punctures one-half puncture width apart with shiny, linear interspaces; metapleural prominences strong, abruptly declivous beneath with very broad, hyaline rims; tegulae light hyaline brown; wings tending to whitish hyaline with sparse, very light pile becoming denser at apex, nervures brown; legs brown, much more blackened basally; posterior basitarsi four times as long as broad. First metasomal tergum densely and finely punctate with shiny interspaces, punctures about one puncture width apart, becoming finer and sparser on the anterior faces; second metasomal tergum very densely and finely punctate or very coarsely folliculated, punctures no more than one puncture width apart, usually much less; metasomal sterna shiny, very finely and sparsely folliculated; seventh ventral plates large and ovate with a dense fringe of light fulvous pile about basal and medial margins, median margins strongly reflexed (fig. 42).

*Female:* length 11.25 mm., wing length 7.75 mm.

Pile of face very short, dense, plumose, and tinged with yellow, particularly about antennal bases; vertex with pile short and tinged with yellow, particularly in ocellar triangle; upper genal areas with pile very short and erect, becoming sparser and much finer below, a very broad band of appressed, whitish to pale grey pile immediately posterior to upper and lateral faces of compound eyes; mesoscutum very densely covered with short, ochreus, mossy pile, completely obscuring surface; scutellum with broad, dense band of light ochreus pile about lateral and posterior margins, pile short, extremely plumose, and mosslike; mesepisterna with pile of upper surface short, dense, and similar to that of mesoscutum, pile be-

coming much finer, longer, and erect below; propodeum with long fringes of light ochreus pile on lateral and posterior margins, pile most dense and longest on extreme dorsal surface, extending as a weak fringe toward the pedicel, lateral faces partially concealed by appressed yellowish pubescence, posterior face with pile erect and pale grey; pile of anterior two pairs of legs very short, sparse, and tinged with pale grey, posterior pair of legs with pile of femora very long, plumose, and tinged with light yellow, tibiae with pile predominantly light ochreus and long, however with abundant, shorter, erect, darker hairs; first metasomal tergum with apical fascia broad, dense, and weakly tinged with yellow, lateral fringes of pile very short and appressed to apical fascia, disc with abundant, short, appressed pubescence, concealing surface except for a very narrow rim immediately anterior to apical fascia; metasomal terga two and three with very broad basal bands of appressed, yellowish pubescence, leaving nonpubescent areas approximately as broad as apical fascia; metasomal terga two to five with the fasciae very broad, fine, and dense, weakly tinged with yellow; metasomal sterna two to five with a weak covering of very fine, erect, tawny pile, not at all forming a fascia.

Antennae deep brown to black, flagellar segments as long as broad; malar spaces one-third as long as broad; clypeus convex, shallowly and rather coarsely striately punctate over surface with broad, shiny interspaces; vertex very shallowly and densely punctate, almost roughened, rather shiny; fascial foveae deep with abundant, appressed pubescence extending at least two thirds of way from inner orbital margins to lateral ocelli. Prothoracic spines absent; mesoscutum very densely and coarsely punctate over anterior half, lateral and posterior faces, punctures almost contiguous, impunctate area small; scutellum very densely, contiguously punctate over posterior one half, punctures becoming sparser toward anterior face, extreme anterior portion shiny, impunctate; mesepisterna coarsely punctate, punctures almost contiguous, interspaces linear and dull; metapleural prominences abrupt and strong with very broad, hyaline rims; propodeum with basal area obscurely, quadrately pitted, weakly sloping ventrally, lateral and posterior faces shiny with a few, sparse, fine punctures evident on posterior face; tegulae brownish hyaline; wings dusky apically with abundant, light fulvous pubescence, nervures brown; legs black; posterior basitarsi four times as long as broad. First metasomal tergum very finely punctate beneath appressed pubescence, punctures one to three puncture

widths apart, becoming much finer and sparser on anterior faces; second metasomal tergum very densely and finely punctate, rather dull, punctures almost contiguous; metasomal sterna shiny, black, sparsely and finely folliculated, metasomal terga two to five with anterior margins brownish hyaline.

The females from the more southerly regions, almost without exception, do not have metasomal terga one to four completely covered with appressed, whitish pubescence. There is usually a broad, nonpubescent area between the basal and the apical fasciae on metasomal terga two and three. There is usually no appressed pubescence at all on the fourth tergum. In the majority of the females taken from the more northerly areas the metasomal terga one to four are completely covered with appressed, whitish pubescence. This would appear to indicate evidences of subspeciation. However, a number of females from Minnesota and Wisconsin agree very closely with the New Mexican material in the tergal covering.

*Distribution:* New Mexico: Jemez Springs; Las Vegas; Albuquerque. Colorado: Roggen. Kansas: Clark County; Decatur County; Phillips County; Ellsworth County; Medora; Syracuse; Manhattan. Nebraska: Neligh. South Dakota: Buffalo. Iowa: Sioux City. Minnesota: Scott County; Anoka County; Jordan. Alberta: Medicine Hat. Wisconsin: Pierce County; Burnett County; St. Croix County. Michigan: East Lansing.

*Flight records:* The species flies from June 19 to August 14, most abundant from mid-July to mid-August.

*Plant records: Melilotus, Petalostemon flavescens, Petalostemon villosum.*

This is the first record of a male of this species. A single male taken from Las Vegas, New Mexico, July 24, 1950 (J. G. Rozen) has been designated as the neallotype and is located in the Snow Entomological Collections of the University of Kansas.

The holotype from Santa Fe, New Mexico, is in the United States National Museum.

### *Colletes saritensis* sp. nov.

(Fig. 43)

This is a sibling species to *susannae* and the males especially are exceedingly difficult to tell apart. The males of *saritensis* differ from *susannae* in the much more coarse but sparse puncturation of the first metasomal tergum and the absence of a basal fascia to the second; the seventh ventral plates of the two species are similar

but in *saritensis* there is a long discal band of pile extending very close to the basal articulatory condyle, this rim of pile is uniform in length and density about the basal half of each plate. The females key out near *americanus;* however, they have the mesepisterna weakly punctate and dull, and have the fascial foveae deep, slightly narrowed and curved medially at the dorsal extremity toward the lateral ocelli.

*Male:* length 10 mm., wing length 6.5 mm.

Pile of face long, rather sparse, about antennal bases and over clypeus, clypeal surface readily visible through weak covering of long, white pile; vertex with pile sparse and pale grey, concentrated principally in ocellar triangle; upper genal areas with pile long, fine, and white, becoming much longer and whiter below, a weak fringe of appressed, white pile immediately posterior to each compound eye; mesoscutum with pile long, sparse, and dusky, median discal area with a large bare patch; scutellum with a weak fringe of long, dusky pile about lateral and posterior margins; mesepisterna with a rather dense covering of long, white, fine pile; propodeum with lateral fringes of long, pale grey pile on upper lateroposterior margins extending part way down to pedicel, lateral and posterior faces with abundant, erect, pale grey pile; pile of legs sparse, short, and pale grey; first metasomal tergum with apical fascia weak, moderately broad medially, becoming narrowed laterally, often interrupted due to wear, pubescence white, lateral fringes weak and white, concentrated principally on anterolateral margins, barely reaching apical fascia, disc with abundant, erect, whitish pile on extreme anterior face, dorsal face very sparsely covered; metasomal terga two to four with fasciae broad, white, and weak, often interrupted probably due to wear; metasomal terga three to six with sparse covering of short, erect, pale grey pile, not at all concealing surface; metasomal sterna two to four with a fringe of whitish pile on apical margins, slightly broadened medially.

Antennae reddish brown, flagellar segments one and one-fourth times as long as broad; malar spaces short, one-fourth as long as broad; clypeus convex, densely and finely punctate over entire surface, punctures becoming striate on apical one third; vertex dull, very densely punctate, fascial foveae narrow and depressed, especially along inner and dorsal margins, extending just a short way above inner orbital margin. Prothoracic spines short, roughly triangular; mesoscutum rather shallowly punctate with shiny interspaces, punctures approximately one puncture width apart on

anterior and lateral margins, becoming very sparse over median posterior discal area where they may be up to two and three puncture widths apart; scutellum with extreme lateral and posterior margins roughened, contiguously punctate, punctures of discal area sparser and separated by linear interspaces, anterior one third shiny, impunctate; mesepisterna rather shallowly and densely punctate, punctures contiguous above to one-half puncture width apart below, interspaces shiny on lower surfaces; metapleural prominences strong with broad, hyaline rims; propodeum abruptly sloping ventrally, irregularly and shallowly pitted, pits not uniform and some barely quadrate, lateral and posterior faces shiny and finely punctate, lateroposterior margins rugose and rather dull; tegulae deep brown to black; wings dusky with abundant, deep fulvous pubescence, nervures brown; legs with coxae and femora deep brown to black, tibiae with extreme apex and base and basitarsi brown, median portions of tibiae deep brown to black; posterior basitarsi four and one-fourth times as long as broad. First metasomal tergum rather densely punctate with shiny interspaces, punctures approximately one puncture width apart laterally, becoming sparser on median and anterior faces where they are up to three and four puncture widths apart, punctures approximately same size as those of mesoscutum; second metasomal tergum very densely and finely punctate, punctures no more than one puncture width apart over entire disc, second metasomal tergum depressed basally; metasomal terga one to four with apical fascial depressions light hyaline brown; metasomal sterna dull, finely and rather sparsely folliculated; seventh ventral plates much as in *susannae,* however with broad, dense, arcuate basal band of erect, fulvous pile extending well up to articulatory condyle and well about the median basal and lateral margins of each plate (fig. 43).

*Female:* length 10 mm., wing length 6.75 mm.

Pile of face erect, white, and sparse, concentrated principally just above antennal bases; vertex with pile tinged with light ochreus, concentrated principally in ocellar triangle; upper genal areas with pile short, dense, and pale grey, becoming much longer, finer, and whiter below, a broad, appressed band of white pubescence immediately posterior to each compound eye; mesoscutum with pile rather dense about anterior one third and lateral margins, pile tinged with fulvous, median discal area bare; scutellum with a broad fringe of dusky to light fuscous pile about anterior and lateral margins; mesepisterna with pile long, fine, and white; propodeum

with dense fringes of long, dusky pile on lateroposterior margins, most dense on upper surfaces, lateral and posterior faces with sparse, erect, pale grey pile; pile of anterior two pairs of legs short, sparse, and dusky, posterior legs with pile predominantly long, plumose, and tinged with light ochreus except on upper surface of posterior tibiae which have abundant, very short, erect, black pile; first metasomal tergum with a broad apical fascia of white pubescence, lateral fringes of long, white pile dense anteriorly, becoming very sparse at apical fascia, disc with abundant, erect, pale grey pile, particularly on anterior surfaces and median discal area, not at all concealing surface; metasomal terga two to five with fasciae broad, white, and rather weak; metasomal terga three to five with discs having a sparse covering of short, erect, pale grey pile; metasomal sterna with apical portions of each disc having a sparse covering of erect, pale grey pile, pile not evident as fringes or a scopa.

Antennae brown, flagellar segments three-fourths as long as broad; malar spaces very narrow, approximately one-sixth as long as broad; clypeus convex, densely and weakly striately punctate to apex, interspaces shiny; vertex very finely and densely punctate, dull; fascial foveae very broad, narrowed on median dorsal extremity and curved toward lateral ocelli, extending almost three fourths of way from inner orbital margins to lateral ocelli. Prothoracic spines short and sharp, barely as long as width across base; mesoscutum densely punctate about anterior one half and lateral margins, punctures about one-half puncture width apart, with shiny interspaces, impunctate area small; scutellum densely punctate over posterior half, punctures almost contiguous, anterior one third shiny, virtually impunctate; mesepisterna dull, densely punctate, punctures just finer than those of mesoscutum; metapleural prominences strong with broad hyaline rims; propodeum with basal area sloping sharply ventrally, very shallowly pitted, pits not uniformly quadrate but irregular, lateral faces dull, posterior face shiny and sparsely punctate; legs dark brown to black; precoxal spines about one and one-half times as long as broad; posterior basitarsi four and one-fourth times as long as broad. First metasomal tergum shiny, weakly and finely punctate, punctures approximately one puncture width apart laterally, becoming much sparser over median surface where they may be up to four puncture widths apart; second metasomal tergum densely folliculated and dull; metasomal sterna dull, rather sparsely folliculated over entire surface; sterna two to five with a narrow, hyaline apical rim.

*Distribution:* Holotype male, allotype female, 5 male and 71 female paratypes, 29 miles south of Sarita, Texas, April 14, 1950 (Beamers, Stephen, Michener, Rozens) taken on *Dalea grisea.*

The holotype is in the Snow Entomological Collections, University of Kansas.

### *Colletes howardi* Swenk

(Fig. 44)

*Colletes howardi* Swenk, 1925, Amer. Mus. Nov., no. 186, p. 5; Brimley, 1938, Insects of North Carolina, p. 451.

This species is most closely related to *susannae* and *saritensis* but can be distinguished from both with little difficulty. The females of *howardi* have the mesoscutum with short, dense, plumose pile giving the surface a mosslike covering, while the males have the metapleural prominences but slightly protuberant and with very narrow, dark rims.

It is known only to occur in the vicinity of Southern Pines, North Carolina, where it is fairly abundant, appearing later in the season than either of its close relatives.

*Male:* length 10-12 mm., wing length 6 mm.

Pile of face weak and scattered, very sparse over clypeus, becoming denser toward inner orbital margins and immediately above antennal bases; vertex with very sparse pubescence; hair of face yellowish, becoming lighter on genal areas and pale grey on lower genal areas; mesoscutum with hair yellowish; pile of mesepisterna greyish white, becoming more grey dorsally; pubescence of abdomen tinged with yellow, especially on basal segments; tergal fasciae wide, yellowish; first metasomal tergum having disc covered sparingly with long, pale yellow pile, short pile clumped along lateral margins; discs of metasomal terga two to six with ferrugineous, short, semierect pile giving surface a reddish tinge; fasciae becoming narrower on metasomal terga four and five and almost nonexistent on sixth metasomal tergum; sternal fasciae pale grey and very narrow, forming a fringe to sterna two to four, slightly broader at mid line; pubescence of legs short, sparse, and pale yellow.

Antennae short, flagellar segments as long as wide, reddish brown in color, becoming darker brown basally; malar spaces one-half as long as wide; clypeus long with weak, shallow punctures over surface, surface dull, flattened medially leaving a weak median longitudinal groove, barely noticeable towards apex. Prothoracic spines strong; mesoscutum with punctures distinct but rather sparse, punctures mesad to parapsidal lines approximately one puncture width

apart, becoming sparser and weaker towards median impunctate area; mesepisterna with surface shiny, punctures close but not contiguous or rugose, approximately one puncture width apart on lower surface, becoming closer on upper surface; hypoepimeral area only slightly protuberant; metapleural prominences weakly protuberant with very narrow, dark rims; propodeum with lateral faces covered by short, sparse, semiappressed pubescence, surface weakly rugose toward posterior edge, lateral posterior edges rounded, becoming more rugose over posterior surface, basal area of propodeum with very weak, quadrate pits, propodeum sloping abruptly behind; wings fulvohyaline, with very weak, scattered pubescence at apex, pubescence ochreus but short, becoming longer and more dense toward the base of wing; wing membrane with whitish tinge, nervures light brown; legs light brown to ochreus, darker brown basally but never black; tarsal segments light to almost yellowish. First metasomal tergum with shallow, dense punctures laterally, becoming shallower and sparser towards mid line, where they are two puncture widths apart, surface shiny and reddish black; second and third metasomal terga with discs roughened, giving impression of very close, shallow punctation; seventh ventral plates as in fig. 44.

*Female:* length 12 mm., wing length 6.5 mm.

Pile of face yellowish, short, and dense, clumped about antennal bases, clypeus free of pubescence; vertex with a few yellowish hairs in ocellar triangle and upper genal areas, pile of lower genal areas sparser, longer, and more pale grey than above; pile of mesoscutum very short, yellow, and mosslike in appearance; pile of scutellum clumped about lateral and posterior edges where it is very dense and very plumose, median anterior portion of scutellum free or relatively free of any pile, yellow pubescence of mesoscutum extending laterally to posterior lobe of pronotum and also to extreme upper surface of mesepisterna; pile of mesepisterna becoming progressively lighter, longer, and paler ventrally; metasomal terga with pubescence very short and appressed; first metasomal tergum with much appressed, yellowish hair on disc, becoming longer toward the basal portion of first segment, a rim of hair on lateral margins of first tergum; metasomal fasciae composed of short, abundant hairs with a yellowish cast most evident on basal terga, fasciae absent on terga five and six; appressed pubescence covering basal half of second and third metasomal terga, becoming sparser on third, not extending to extreme lateral margins on either terga; fasciae of terga two to four sharply narrowed laterally as in male; sternal

fasciae absent; pile of legs very short and ochreus on first two pairs, posterior femora with pile long and yellow.

Antennae short, dark reddish brown; malar spaces half as long as wide; clypeus weakly convex, flattened medially, surface with weak, elongate punctures, becoming less distinct towards upper lateral edges, surface dull. Prothoracic spines very long, directed laterally; punctures of mesoscutum shallow but very dense, those on anterior portion almost contiguous, becoming elongate mesad from the posterior edges of parapsidal lines, impunctate area small; mesepisterna with surface dull, punctures on lower half very shallow and separated by at least one puncture width, punctures becoming obscure and closer toward upper and posterior edges of mesepisterna; metapleural prominences weakly protuberant, rimmed with very narrow, dark rims, only slightly concave beneath; lateral surface of propodeum covered with short, semi-appressed hairs, surface very weakly rugose, basal area of propodeum with distinct, quadrate pits; wings whitish hyaline with short, scattered, fulvous pubescence, nervures yellowish brown; tegulae ochreus hyaline; legs dark brown to ochreus in color, darkest at base of each leg; posterior basitarsi with a weak longitudinal groove on the posterio-dorsal surface. First metasomal tergum with minute, shallow punctures over entire surface, most dense at lateral extremities, sparser towards mid line; second and third metasomal terga with discs feebly but densely punctate, fascial portions of terga impunctate, smooth, and shiny; metasomal sterna with discs densely folliculated.

*Distribution:* Southern Pines, North Carolina.

*Flight records:* September 7 to 20.

*Plant records: Kuhnistera pinnata, Petalostemon corymbosum.*

The holotype from Southern Pines, North Carolina, is in the collection of the University of Nebraska.

### *Colletes susannae* Swenk

(Fig. 45)

*Colletes susannae* Swenk, 1925, Amer. Mus. Nov., no. 186, p. 1; Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 99; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 400.

The resemblance of *susannae* to *howardi* and especially *saritensis* is striking, and their separation is at times difficult. The isolated *howardi* is the most easterly member of this subgroup and can readily be distinguished by the short, dense, mosslike pile of the mesoscutum. *C. susannae* and *saritensis* appear to be mutually ex-

clusive in range, *susannae* occurring in or north of Kansas and Colorado while *saritensis* is known only from Texas. Morphologically the differences are minor but consistent and the two species can be separated by characters cited in the preamble to *saritensis.*

*Male:* length 9 mm., wing length 6.5 mm.

Pile of face pure white and erect, becoming more erect along inner orbital margins; clypeus with pile dense basally, becoming sparse apically; vertex with a clump of pale grey pubescence in ocellar triangle; genal areas covered with long, loose, pure-white pile; mesoscutum with pile long, white and slightly plumose; scutellum with pile long, white, and dense on lateral and posterior edges, anterior face free of pile; lateral lobe of pronotum with a weak covering of white pile; mesopleura with long, loose, sparse, white pile not concealing surface; propodeum with lateral faces concealed by a few, partially appressed, white hairs, dense fringes of long, white pile on upper dorsolateral surfaces, posterior face with a few, long, white hairs; femora with abundant, long, white pile, tibiae and tarsi having short, whitish, nonplumose pubescence; first metasomal tergum with abundant, long, erect pile on anterior face of disc, becoming sparser toward dorsal face, tergum with dense lateral fringe of long, white pile extending posteriorly to fascia; metasomal terga with wide fasciae of pure white pubescence; second metasomal tergum with a weak basal fascia; discs of metasomal terga two to five with sparse, short, white, semierect pubescence giving a whitish sheen to surface when viewed laterally; sternal fasciae complete, slightly broadened medially, pure white.

Antennae reddish brown, becoming black basally, flagellar segments as long as wide; malar spaces three-fourths as long as wide; clypeus weakly convex, basal half covered with dense, minute punctures, giving surface dull appearance, punctures sparser and more elongate apically, extreme lateroapical surfaces shiny with a few, elongated, coarse punctures, punctures uniformly dense along mid line from base to apex; vertex dull, densely punctate with minute punctures. Prothoracic spines absent; mesoscutum shiny with extreme anterior face finely punctate with a few sparse punctures becoming deep and coarse laterally and posterior to median anterior portion of scutum, punctures along inner margins of parapsidal lines fine and approximately one puncture width apart, punctures along extreme posterior edge of mesoscutum much finer than those on disc, impunctate area large; scutellum dull, posterior two thirds rough and rugosely punctate, punctures obscure; mesopleura with

surface dull, punctures shallow but distinct, about one to one and one-half puncture widths apart on disc, becoming denser almost contiguous above and obscure on extreme posterior margin; metapleural prominences greatly protuberant with very broad, light testaceous rims, sharply concave beneath; propodeum with lateral faces rather dull beneath semiappressed pubescence, weakly and finely rugose, lateroposterior margins of propodeum weakly rounded with no ridge, basal area with shallow, quadrate pits, posterior face roughened and much duller than lateral faces; tegulae light brownish hyaline; wings whitish hyaline with some sparse, whitish pubescence, nervures light yellowish brown, except for subcosta-radius which is dark brown; legs deep red-brown basally, tarsi and tibiae yellowish; posterior basitarsi five to six times as long as wide. First metasomal tergum with disc finely and densely punctate, punctures on lateral margin approximately one puncture width apart, becoming sparser toward mid line but never more than two puncture widths apart; apical fasciae of first metasomal tergum in a weakly depressed rim; metasomal terga two to four densely folliculated; seventh ventral plates as illustrated in figure 45.

*Female:* length 10-11 mm., wing length 7 mm.

Pile of face white, concentrated principally along inner orbital margins and about antennal bases; clypeus with a few shorter hairs, never concealing surface; genal areas with short, white, erect pile over entire surface, except for a narrow portion with appressed pubescence immediately posterior to compound eyes; mesoscutum with abundant, short, plumose pubescence over surface, shortest and most dense at extreme posterior edge; scutellum with lateral and posterior fringe of longer, more plumose, and much denser pile, disc free of pile; propleura with sparse covering of pure white, sparse pubescence; mesepisterna with abundant, long, erect, white pile over surface, pile not distinctly plumose on lower portions; metapleura covered with shorter, somewhat appressed pubescence; propodeum with lateral faces having sparse, appressed, long, white pile, laterodorsal edges with dense, long, white fringes of hair extending posteriorly halfway towards the pedicel; first and second pairs of legs with posterior fringes of long, white pile on femora, becoming very short on tibiae and tarsi; posterior legs with femora covered with long, curved pile tinged with ochreus, tibiae with dense, short pile, also with a slight ochreus tinge; metasomal terga almost completely covered with short, white, appressed pubescence, a very narrow, shiny, nonpubescent area immediately anterior to

apical fasciae and posterior to appressed pubescence of each disc; first metasomal tergum with weak lateral fringes extending to fascia, disc with basal three fourths covered with short, white, appressed pubescence; fasciae dense, white; shiny surface of disc partially visible beneath weak, appressed pubescence; metasomal tergum six with disc covered with semierect, fulvous to ferrugineous pile giving surface a golden sheen; sternal fasciae weak and uniform, composed of a few rows of long, white pile at extreme apical margin, most evident on metasomal sterna two and three.

Antennae short, reddish brown to base; malar spaces one-third as long as wide; clypeus weakly convex, shiny black, covered with coarse, elongate punctures to apex; vertex dull, finely punctate. Prothoracic spines short and sharp; pronotum expanded between spine and mesoscutum to form a weakly convex area; mesoscutum coarsely and densely punctate on disc, punctures becoming much shallower, finer, and more dense on extreme anterior median face, punctures median to parapsidal lines less than one puncture width apart, impunctate area large; scutellum with posterior two thirds dull, with shallow, obscure punctures; mesopleura dull, shallowly and obscurely punctate, punctures barely distinguishable on ventral portion of mesopleura, becoming completely obscure on dorsal and posterior faces; metapleural prominences greatly protuberant, with broad, light testaceous rims; propodeum with lateral faces weakly papillate, giving it a weakly roughened appearance, lateroposterior edges weakly rounded with no sharp ridge separating the two surfaces, basal area with broad, shallow, quadrate pits; tegulae light hyaline brown; wings whitish hyaline with a sparse covering of short, white pubescence, nervures yellow except for subcosta-radius which tends to reddish brown; legs brown, blackened basally; posterior basitarsi four times as long as wide with a shallow groove on dorsal posterior surface; posterior tibiae with evidence of a continuation of the weak shallow groove on the posterior portion of upper face. First metasomal tergum with disc shiny and very finely punctate beneath appressed pubescence, punctures at least two puncture widths apart covering the surface; second metasomal tergum with punctures very much finer.

*Distribution:* Manitoba: Aweme; Onah. Alberta: Medicine Hat. Wisconsin: Burnett County; St. Croix County; Waukecha County. Minnesota: Fort Snelling; Hennepin County; Scott County; St. Croix County; Washington County; Winona County. Iowa: Sioux City. South Dakota: Brookings; Buffalo; Mobridge; Hot Springs;

Pierre; Redig. Nebraska: Glen Sioux County; Haigher; Lincoln; Meadow; Mitchell; Sioux County; Weeping Water. Kansas: Clark County; Jewell County; Republic County. Colorado: Poudre River.

*Flight records:* July 1 to August 18.

*Plant records: Helianthus, Kuhnistera purpurea, Petalostemon violaceus, P. purpureum.*

The appressed pubescence on the metasomal discs of the female appears to be almost complete on the type specimens as described from western Nebraska. Specimens taken in Kansas, eastern Nebraska, Iowa, South Dakota, Minnesota, and Manitoba indicate that this appressed pubescence is very weak and sparse in many cases and only rarely does it completely cover the discs to the fasciae. There is usually a distinct, narrow, nonpubescent area just anterior to the apical fascia of each of the first five metasomal terga. A specimen labeled Okanagan Falls, B. C., is well out of the known range of the species and may have been mislabeled.

The holotype from Lincoln, Nebraska, is in the collections of the University of Nebraska.

### *Colletes thysanellae* Mitchell

(Fig. 46)

*Colletes thysanellae* Mitchell, 1951, J. Elisha Mitchell Sci. Soc., vol. 67, p. 238.

This species is easily distinguishable from the rest of the *americanus* group for it is the only member of this group which has a strong admixture of black and dark brown hairs on the disc of the mesoscutum and on the lateral and posterior edges of the scutellum. The metapleural prominences are narrowly rimmed with dark brown.

*Male:* length 8-9 mm., wing length 5-5½ mm.

Pile of face light ochreus to pale grey, pile short, not obscuring surface; clypeus with sparse pile; ocellar triangle with a few, long, erect, ochreus hairs; genal areas with erect, ochreus pile dorsally, becoming pure white and much longer on extreme ventral portions; mesoscutum covered with pale grey to ochreus pile with a strong admixture of black hairs; scutellum with a similar strong admixture of black hairs among dominating ochreus pile; pile of scutum and scutellum sparse, not obscuring surface; pronotum with lateral faces free of pile, posterior lobe with a dense white clump of pubescence; mesepisternum with sparse, pale grey to ochreus pubescence, becoming more grey above; propodeum with lateral and posterior

faces with little to no pubescence, dorsolateral edges with rather dense, long fringes of white to grey pile; legs with short, plumose pile on coxae, trochanter, and femora, pile of tibiae and tarsi short, semiappressed, and weakly plumose; first metasomal tergum with a few, erect, pale grey hairs most evident on anterior face of disc, extending to the dorsal face, lateral fringes weak and grey; metasomal fasciae weak and narrow, broadest laterally; discs of metasomal terga two to five with abundant, short, semierect, ochreus to light ferrugineous pile; metasomal terga five and six with fasciae absent; sternal fasciae straight, composed of a few rows of weak, white pile, most evident on sterna two, three, and four.

Antennae reddish brown, blackened basally, flagellar segments slightly longer than broad; malar spaces one-third as long as wide; clypeus weakly convex and shiny, with abundant shallow punctures over surface, punctures rounded except on extreme apical margin where they tend to be striate; vertex dull with abundant coarse punctures. Prothoracic spines short and sharp, directed dorsally; pronotum expanded slightly between spine and mesoscutum; mesoscutum shiny, coarsely but shallowly punctate, punctures approximately one puncture width apart anteriorly, becoming sparser towards ends of the parapsidal lines where they are one and one-half puncture widths apart; scutellum with basal two thirds dull and shallowly punctate; pronotum with lateral faces shiny impunctate; mesepisterna shiny with weak, shallow punctures, most evident on lower face, becoming obscure dorsally and posteriorly; hypoepimeral areas as strongly protuberant as metapleural prominences, with strong ridges on lower edge; metapleural prominences strong with narrow, dark brown to black rims, not sharply concave beneath; propodeum with lateral faces shiny, laterodorsal and lateroposterior faces weakly rounded, posterior face rugose, dull, basal area with deep quadrate pits; tegulae light hyaline brown; wings with whitish hyaline membrane, dusky due to abundant, short, ochreus pubescence on surface, nervures brown, stigma dark brown; legs brown; posterior basitarsi four times as long as wide. First metasomal tergum with disc shiny impunctate; metasomal terga two and three with discs shiny, weakly and sparsely folliculated; seventh ventral plates much as in *wilmattae* but more densely pubescent (fig. 46).

*Female:* length 9-11 mm., wing length 6 mm.

Pile of face sparse, almost absent except for a few, erect, pale grey to ochreus hairs on surface; vertex with a few, dark brown

hairs; genal areas with upper portion having a few, scattered, ochreus to greyish hairs, becoming denser and more distinctly greyish below; mesoscutum sparsely pubescent with a strong admixture of black and dark brown pile amongst the ochreus; scutellum with a few black hairs especially noticeable on lateral and posterior edges; pronotum with lateral faces shiny; mesepisterna with sparse covering of erect, plumose, white to grey pile; propodeum with lateral faces free of pile, fringes of long, whitish pile on laterodorsal edges, extending ventrally to the pedicel, posterior face with a few, scattered, long, white hairs; anterior two pairs of legs with sparse pile tinged with ochreus except for that of basitarsi which tends towards deep ochreus, pile of posterior femora very long, dense ochreus, and extremely plumose, that of tibiae shorter, dense, and tending to ferrugineous at base, basitarsi with deep ochreus to ferrugineous pile; first metasomal tergum with a few, scattered, ochreus hairs on anterior surface and a weak lateral clump of hairs at dorsoanterior edge of disc; metasomal terga with very weak, white to ochreus fasciae, easily removed by rubbing; first metasomal tergum with fascia very narrow medially, almost absent; metasomal terga two to five with discs covered with a short, deep ochreus, semierect pile giving the surface a golden sheen; sternal fasciae absent.

Antennae short, grey brown, becoming deep reddish brown basally; malar spaces one-fourth as long as wide; clypeus weakly convex, dull, with a few, coarse, shallow punctures scattered uniformly over the surface; vertex dull and roughened; fascial foveae deep and dull. Prothoracic spines short and sharp, directed dorsolaterally; mesoscutum shiny with dense, coarse, shallow punctures on anterior portion, becoming sparser and deeper towards the end of the parapsidal lines, impunctate area small; scutellum with posterior three fourths roughened and dull; pronotum with lateral faces shiny, expanded slightly as in *aberrans;* mesepisterna rugosely punctate, punctures obscure giving surface dull roughened appearance; hypoepimeral areas sharply protuberant, about as equally protuberant as metapleural prominences with strong ridges at ventral edge; metapleural prominences strong with very narrow, dark brown rims, not strongly concave beneath; propodeum with lateral faces dull, weakly papillated, giving it a finely roughened yet shiny appearance, basal area with shallow, quadrate pits, lateroposterior edges separated by a weak ridge running from dorsal surface to pedicel; tegulae brownish hyaline; wings dusky, covered with fine, ochreus

pubescence, nervures brown, stigma dark brown; legs deep reddish brown; posterior basitarsi four times as long as broad. First metasomal tergum with disc shiny impunctate; second and third metasomal terga with discs shiny, weakly folliculated; sterna with posterior margins straight.

*Distribution:* Pensacola, Florida, October 11-14, 1914 (holotype and allotype); 9 females, Inverness, Florida, 1918 (Chas. Robertson) (paratypes); 6 males, 2 females, Pensacola, Florida, October 11-14, 1914 (paratypes); 2 males, Miami, Florida, October 21 and 23, 1934 (J. Pearson) (paratypes); 1 male, St. Simon's Island, Georgia, October 22, 1910 (paratype); 1 male, Gainesville, Florida, October 9, 1946; 1 female, Gainesville, Florida, November 6, 1946; 2 males, New River, North Carolina, September 20-30, 1944 (G. E. Bohart); 2 males, 6 females, Virginia Beach, Virginia, October 6 (Fred Knab).

The holotype is in the American Museum of Natural History.

### *Colletes wilmattae* Cockerell

(Fig. 47)

*Colletes wilmattae* Cockerell, 1904, Canadian Ent., vol. 36, p. 14; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 404.

This is one of the more distinctive members of the *americanus* group and is found nesting in the sandy regions of the Great Plains from New Mexico to Manitoba. The female has metasomal terga one to five entirely covered with short appressed pubescence and in both sexes the legs are yellow to brown-yellow.

*Male:* length 10 mm., wing length 6 mm.

Pile of face dense whitish, tinged with yellow, hair long and loose over clypeus and about antennal bases; vertex with short, white, appressed pubescence extending below ocelli; ocellar triangle and upper genal areas with considerable, long, erect, yellowish pile, pile close and appressed immediately behind compound eyes, becoming longer, more erect, and whiter over remaining portion; mesoscutum with hair dense, tinged with ochreus; scutellum with a heavy fringe of pale grey to white hair about lateral and posterior margins; mesepisternum with long, loose, white to pale grey pile not obscuring surface; metapleura more densely haired than mesopleura with pile shorter, whiter, and much more plumose; propodeum with lateral faces concealed by semiappressed pubescence varying from pale grey to pure white, posterolateral margins and posterior face of propodeum with abundant, erect, long hair; legs with sparse,

white pubescence, short and not distinctly plumose; first metasomal tergum with anterior face of disc covered with abundant, long, white, erect pile, occasionally tinged with yellow or ochreus, pile becoming shorter and more appressed toward posterior portion of the disc, weak lateral fringes; metasomal terga one to five with very broad, dense fasciae; second metasomal tergum with broad basal fascia; metasomal terga two to five with discs covered by fine, erect, whitish pile giving the surface a whitish sheen unlike snowy white fasciae; sternal fasciae uniform throughout.

Antennae short, flagellar segments barely longer than wide; malar spaces about one-half as long as wide; clypeus convex, densely punctate with fine punctures on basal half, punctures becoming sparse on lateral portions of apex, where interspaces are large and shiny; vertex shiny beneath appressed pubescence with a few scattered punctures. Prothoracic spines short and sharp; pronotum expanded slightly behind prothoracic spines forming a concave depression before mesoscutum; mesoscutum deeply and densely punctate with fine punctures, punctures on anterior portion of mesoscutum not more than one puncture width apart, becoming sparser toward impunctate area, punctures posterior to impunctate area as dense as those on anterior portions; scutellum with posterior half finely, rugosely punctate, anterior half shiny, impunctate; mesepisterna shiny below, punctures shallow and at least one and one-half puncture widths apart, punctures on upper portion becoming more dense and almost contiguous giving surface a dull cast; metapleural prominences abruptly protuberant with broad, testaceous rims, abruptly concave below; propodeum with lateral faces shiny and smooth beneath appressed pubescence, basal area of propodeum with shallow, quadrate pits; tegulae yellowish hyaline; wings whitish hyaline with scattered, short, ochreus pubescence giving them a dusky tinge, nervures and stigma light yellowish brown, becoming darker apically; legs with coxae, trochanters, and basal portions of the femora dark, apical part of femora, tibiae, and tarsi bright ochreus-yellow; posterior basitarsi long and slender, at least four and one-half times as long as wide. First metasomal tergum with dense, shallow punctures most evident on lateral margins of the disc, punctures shallow and fine, approximately one puncture width apart, surface shiny black; seventh ventral plates much as in *thysanellae* but with discs sparsely pubescent medially (fig. 47).

*Female:* length 10-11 mm., wing length 6 mm.

Pile of face short, dense, and clumped about the lower inner

orbital margins and antennal bases, extending up to form a mat of appressed pubescence about fascial foveae and completely obscuring vertex; ocellar triangle with abundant, erect, yellowish pile extending over upper genal areas; pubescence immediately behind the compound eyes short, white, and appressed, becoming more elongate and erect on posterior and ventral surfaces of genal areas; pronotum with lateral faces having long, slender, appressed, white pile on surface; mesoscutum with short, dense, mosslike pubescence strongly tinged with yellow concealing entire surface; scutellum with a dense, short, erect lateral and posterior fringe of plumose hairs, with a few weakly appressed hairs extending forward to cover anterior surface of scutellum; mesepisterna with short, mosslike pubescence above, becoming longer and much finer below, changing from yellowish above to a tawny grey below; metapleura completely concealed by short, dense pile; lateral faces of propodeum covered by a fine mat of slender hairs appressed to the surface, upper lateral edge with long fringes, extending down along the lateroposterior edges to pedicel, posterior face of propodeum covered with long, erect pile; first two pairs of legs with short, white pile, that of the posterior femora elongated, curved, and ochreus in color, pile of posterior tibiae and tarsi short and tinged with ochreus; metasomal terga completely obscured by short, appressed pubescence tinged with yellow, fasciae distinguishable as denser mats of pubescence; pile on vertical face of first metasomal tergum erect and dense, becoming more appressed as it reaches dorsal surface; metasomal tergum six with erect, dark ferrugineous pile giving surface a deep reddish brown tinge; sternal fasciae absent, except for a few ochreus hairs towards apical portion of each sternum.

Antennae short, dark brown to black except for the scape and pedicel which are light brown; malar spaces one-fourth as long as wide; clypeus weakly convex, with surface dull, covered with elongate punctures except on apical margin where punctures are very shallow to obscure; vertex dull and densely covered with fine punctures beneath appressed pubescence. Prothoracic spines short and blunt, a weak pronotal expansion between prothoracic spines and mesoscutum; mesoscutum densely covered with shallow, dense punctures, punctures close and almost contiguous on anterior, lateral, and extreme posterior faces of mesoscutum, punctures no more than one puncture width apart except on small impunctate area; scutellum densely covered with fine, shallow punctures posteriorly, anterior one-third shiny impunctate; mesepisterna with

shallow, sparse punctures below, punctures at least one puncture width apart, becoming much finer and extremely dense, almost contiguous on upper surface, punctures almost completely obliterated on posterior face, interspaces shiny on most of surface; metapleural prominences strong with very narrow, dark brown rims, testaceous on the extreme margins; propodeum with lateral faces dull and weakly roughened, almost papillated surface, lateroposterior edge of propodeum weakly rounded, basal area with shallow, quadrate pits, posterior face dull and roughened as on lateral faces; tegulae ochreus hyaline; wings dusky hyaline covered with short, ochreus pubescence, nervures light brownish yellow; legs light brownish yellow, coxae occasionally dark brown to black; posterior basitarsi about three and one-half times as long as wide, with a shallow longitudinal groove on the posterior portion of dorsal surface. First metasomal disc shiny, covered with shallow, minute punctures beneath appressed pubescence, punctures very fine and separated by shiny interspaces at least two puncture widths apart on lateral surfaces; second metasomal tergum as first, with punctures finer and denser.

*Distribution:* Manitoba: Aweme; Onah. Wisconsin: Burnett County; Pierce County; St. Croix County. Minnesota: Ramsey County. Iowa: Sioux County. Nebraska: Halsey; Glen Sioux County; Sioux County. Texas: Fedor; Romney. New Mexico: Albuquerque; Hot Springs; Isleta; Las Vegas; San Jose.

*Flight records:* May 31 to September 9.

*Plant records: Petalostemon candidum; P. flavescens; P. oligophyllum.*

The species appears to be an oligotrophic visitor on *Petalostemon* and data on hand would indicate it as having but one generation per year, flying from late May in the south to early September in the north.

The holotype from Pecos, New Mexico, is in the collection of the Citrus Experiment Station, Riverside, California.

### *Colletes micheneri* sp. nov.

The species closely resembles *solidaginis* Swenk except in having the hair pure white to tawny grey; the wings whitish hyaline with short, sparse, white pubescence over the surface; and the male genitalia closely resembling and almost indistinguishable from *wilmattae* Cockerell (fig. 47). The extreme apical margin of each seventh ventral plate of *micheneri* is much longer in proportion to

the height than it is in *wilmattae;* the pubescence of the former is also much sparser about the lateral apical edges. The female can readily be distinguished from other closely related species by the white hyaline wings, the short malar spaces, and the shiny, impunctate first metasomal tergum.

*Male:* length 6-7 mm., wing length 5 mm.

Pile of face dense and white, completely concealing clypeus; vertex with pile sparse and slightly grey; upper genal areas with pale grey pile, becoming much longer and pure white on ventral surfaces; mesoscutum with sparse covering of long, fine, pale grey pile; scutellum with a few, scattered, pale grey hairs, particularly about posterior and lateral margins; mesepisternum with long, sparse, fine, pale grey hairs; metapleura with a few pale grey hairs; propodeum with lateral faces covered by a few, semiappressed, pale grey hairs, dorsolateral fringes weak to absent, posterior face with a few white hairs; legs with short, white, sparse pile; first metasomal tergum with distinct lateral fringes of white pile extending to apical fascia, anterior face with a little grey pile, extreme lateral faces of disc with a few, scattered, white hairs; fasciae broad and shaggy white; second metasomal tergum with a weak basal fascia; metasomal terga two to four with abundant, fine, white discal pile; metasomal sterna with uniform apical fringes of white hair.

Antennae short, flagellar segments about as long as wide, deep brown; malar spaces one-half as long as wide; clypeus weakly convex and shiny, covered with obscure shallow punctures, surface rugose, tending to striate rugoseness at apex; vertex shiny impunctate. Prothoracic spines long and sharp, directed dorsally; mesoscutum shiny, punctures of disc extremely sparse and fine, at least three puncture widths apart, punctures at extreme anterior lateral margins fine, obscure, giving surface slightly roughened appearance; scutellum with posterior one third rugosely punctate, anterior two thirds shiny with a few, scattered, weak punctures; mesepisternum shiny with a few, sparse, shallow punctures, almost follicular, punctures at least three puncture widths apart, giving surface an impunctate appearance; metapleural prominences greatly protuberant with very broad testaceous rims, sharply declivous beneath; propodeum with lateral faces shiny on anterior half, becoming roughened posteriorly, dorsolateral and posterolateral margins weakly rounded, basal area with shallow quadrate pits, posterior face weakly roughened and shiny; tegulae dark brown hyaline; wings whitish hyaline with sparse covering of light to tawny pubescence, nervures dark

brown; legs deep brown except for tarsi which are tinged with yellow; posterior basitarsi about six times as long as wide. First metasomal tergum shiny with sparse, weak, folliclelike punctures separated by at least four puncture widths on mid discal area; metasomal terga two and three with discs densely folliculated, interfollicular areas shiny; metasomal sterna with posterior margins straight.

*Female:* length 8 mm., wing length 5½ mm.

Pile of face sparse and pure white, concentrated principally about the antennal bases; clypeus with a few, scattered, tawny hairs over surface; vertex with a few, scattered, pale grey hairs; upper genal areas with short, pale grey pile becoming much longer and denser towards ventral surface, a small amount of appressed, white pubescence immediately posterior to compound eyes; mesoscutum with sparse covering of pale grey pile; scutellum with weak lateral and posterior fringe of white to pale grey pile; metanotum with a few, fine, pale grey hairs; propodeum with lateral face having a few, long, fine hairs on extreme anterior margin, dorsolateral margins with dense fringes of long, white pile extending halfway to pedicel, posterior face with a few, long, white, scattered hairs; anterior two pairs of legs with short, sparse, pale grey to light ochreus pile; posterior femora with long, curved, plumose pubescence, tibiae with very long, weakly plumose pile; first metasomal tergum with lateral fringes of white pile, longest and most dense at dorsal anterior margin, becoming sharply reduced posteriorly towards fascia, anterior face with a few, long, fine, white hairs; metasomal fasciae broadest on sixth tergum, becoming progressively narrower towards first; second metasomal tergum with broad, white basal fascia; discs of metasomal terga two to five with very short, fine, light ochreus pile inconspicuous but giving surface a whitish sheen; metasomal sterna nonfasciate.

Antennae short, brown to black at base; malar spaces one-fourth as long as wide; clypeus weakly convex, shiny, covered with scattered, short, striate punctures; vertex shiny and sparsely punctate. Prothoracic spines short and sharp, directed dorsally; mesoscutum shiny, with obscure, shallow punctures which are distinct only on extreme anterior lateral face, surface weakly rugose, impunctate area very large; scutellum with posterior one-third deeply rugosely punctate, anterior two thirds shiny with a few scattered punctures; mesepisterna dull and roughened due to extreme shallowness of puncture depressions, punctures obscure and very dull above; metapleural prominences strongly protuberant with broad testaceous

rims, sharply concave beneath; propodeum with lateral faces dull and weakly striately papillated, giving surface a roughened appearance, basal area with shallow quadrate pits, sloping slightly posteriorly, posterior face roughened and dull; tegulae deep brown hyaline; wings whitish hyaline with short, tawny to white pubescence, nervures brown; legs deep brown to black to apex; posterior basitarsi five times as long as wide. First metasomal tergum with disc shiny impunctate, except for a few, scattered, folliclelike depressions; metasomal terga two and three weakly but densely folliculated giving surface a roughened, dull appearance; metasomal tergal fasciae in lowered, brownish hyaline depressions; metasomal sterna with posterior margin straight.

*Distribution:* Holotype, male, Halsey, Nebraska, August 13, 1925 (R. W. Dawson); allotype, female, National Forest, Halsey, Nebraska, August 4, 1948 (Dreisbach); 2 male paratypes, National Forest, Halsey, Nebraska, August 4, 1948 (Dreisbach).

The holotype is in the Snow Entomological Collections of the University of Kansas.

### *Colletes mandibularis* Smith

(Fig. 48)

*Colletes mandibularis* Smith, 1853, Cat. Hymenoptera British Mus., pt. 1, p. 5; Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 171; Viereck, 1902, Canadian Ent., vol. 34, p. 329; 1903, Ent. News, vol. 14, p. 120; Cockerell, 1904, Ent. News, vol. 15, p. 276; 1905, Psyche, vol. 12, p. 87; Graenicher, 1930, Ann. Ent. Soc. Amer., vol. 23, p. 154; Brimley, 1942, Supp. Insects North Carolina, p. 36.

*Colletes similis* Robertson (not Schenck), 1904, Canadian Ent., vol. 36, p. 276; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario for 1919, p. 132; Robertson, 1928, Flowers and Insects, p. 10; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 224 (new synonymy).

*Colletes simulator* Michener, 1951, *In* Muesebeck, Krombein and Townes, Hymenoptera of Amer. North of Mexico, U. S. D. A. Agric. Monog. no. 2, p. 1048 (new name for *similis* Robertson) (new synonymy).

The short description of *mandibularis* Smith falls in close accord with specimens labelled *similis* from Georgia. Dr. I. H. H. Yarrow of the British Museum has examined the Smith type and it is found to be identical with that of *similis.* The name *simulator* Michener proposed to replace *similis* Robertson (preoccupied by *similis* Schenck), similarly falls in favor of the older *mandibularis.*

This species and *solidaginis* are sibling species, with *mandibularis* occupying the southern portions of the area east of the continental divide and extending into Idaho, Colorado, and Utah. The females, unlike *solidaginis*, have the appressed pubescence of the metasoma restricted to a basal fascia on the second tergum and have the first

metasomal tergum finely and densely punctate laterally. In the males the first tergum is shiny, finely and sparsely punctate, the prothoracic spines are long and sharp and the flagellar segments are at least one and one-half times as long as wide.

*Male:* length 7-9 mm., wing length 5-6 mm.

Pile of face long and loose and tinged with yellow to pale grey, apical end of clypeus only lightly covered with pubescence; vertex almost bare with a few yellowish hairs over upper genal areas, lower genal areas with long, white pubescence; mesoscutum with hair long, pale grey yellow; pile of scutellum very long and concentrated on lateral and posterior faces; mesopleuron with scattered, white to pale grey pubescence over surface, becoming more pale yellow towards upper surface; pubescence of abdomen white, occasionally tinged with yellow or pale grey, especially on basal segments; first metasomal tergum with long, scattered, yellowish pubescence on disc; fascia of first metasomal tergum extending laterally to meet lateral rim of clumped pubescence; abdominal terga two to five with fasciae ending at lateral margins by an abrupt tapering; discs of terga two, three, and four with a few, short, semierect, yellowish hairs giving a golden sheen to terga; sternal fasciae very weak, broadest at midline, fasciae composed of a few white hairs.

Antennae long, flagellar segments one and one-half times as long as wide, basal flagellar segment less than one-half as long as second; malar spaces one-half to two-thirds as long as wide; clypeus deeply and closely punctate, punctures elongate giving surface a weak rugose appearance, clypeus flattened; vertex shiny with few, weak, shallow punctures. Prothoracic spines short and sharp; mesoscutum with surface shiny, punctures on anterior portion approximately one to two puncture widths apart with shiny interspaces, punctures becoming coarser towards ends of the parapsidal lines; anterior half of scutellum shiny impunctate except for a few, scattered, very shallow punctures; mesepisterna very shiny over entire surface, punctures deep and distinct, at least one puncture width apart, interspaces smooth and shiny; metapleural prominences strong with very broad, testaceous rims, abruptly declivous beneath; basal area of propodeum with shallow, quadrate pits, lateral face roughened to rugose posteriorly, lateroposterior angle of propodeum rounded and rugose; wings dusky, with abundant, ochreus, short pubescence over surface, nervures yellowish-brown; legs with abundant, short, tawny pile, apical end of tibiae and tarsi

ochreus to yellowish, coxae, femora, and apical portion of tibiae dark. First metasomal tergum punctate with very shiny interspaces, punctures on lateral margins of first metasomal tergum one to two puncture widths apart, becoming sparser towards mid line; second metasomal tergum with dense, close, minute, shallow punctures; seventh ventral plates with discs extended laterally, dense fringes of pile about lateral and median margins (fig. 48).

*Female:* length 10.5 mm., wing length 5.5 mm.

Pile of head short, dense, clumped about antennal bases and along inner orbital margins, yellow to pale grey; pile on vertex yellowish, clumped in upper genal areas and in ocellar triangle; pubescence of lower genal areas white to pale grey; pubescence on mesoscutum short, plumose, and tinged with yellow over entire surface; scutellum with pubescence concentrated on posterior half, anterior half of scutellum without pile; mesepisterna with long, scattered, pale grey pile on surface, becoming more yellowish on upper areas; propodeum with short, somewhat appressed pubescence on upper part of lateral propodeal face, posterior face of propodeum with a few, long, pale grey hairs; pile of legs white and long, especially on posterior femora and tibiae, that of anterior pairs of legs scarce except on posterior margins where it forms a long, brushlike rim; pubescence of abdomen pale grey to yellow on apical segments, becoming lighter to almost pure white on apical two segments; last segment of abdomen with ferrugineous, semierect pile; pubescence of first metasomal tergum appressed to semierect extending from the extreme frontal region to apical fascia, tergum with lateral rim of yellowish pile; fascia narrow on first metasomal tergum, becoming progressively whiter apically; third metasomal tergum with weak basal fascia; discs of metasomal terga three and four with semierect, ochreus to pale yellow pile giving the surface a sheen; sternal fasciae absent, a few pale grey to yellowish hairs on extreme apical margins of sterna, especially sterna two and three.

Antennae reddish-brown to black at base of the flagellum, first flagellar segment as long as second; malar spaces one-fourth as long as wide; clypeus bare with deep, coarse punctures, tending towards elongation, interspaces shiny; vertex shiny with few, scattered, shallow punctures. Prothoracic spines very long and sharp; mesoscutum deeply punctate, interspaces very shiny, punctures less than one puncture width apart on anterior half, becoming more sparse to ends of the parapsidal lines, punctures about lateral and

posterior edges as on anterior half of mesoscutum, a very small, impunctate discal area; scutellum with anterior half smooth and shiny; mesepisterna with coarse, close punctures, becoming closer on upper faces and tending to rugosity, punctures on posterior edge of mesoscutum shallower than those on the disc of the mesepisterna but do not approach the rugosity as in *americanus;* metapleural prominences distinct with narrow, testaceous rims, abruptly declivous beneath; propodeum with shallow, quadrate pits at basal area, lateral faces of propodeum smooth and shiny, posterolateral edges separated by a distinct elevated ridge which runs from abdominal pedicel up to basal area of the propodeum; spine on front coxae short and stout, not more than twice as long as broad, hind basitarsi about three times as long as wide. First metasomal tergum with disc densely punctate with very fine, shallow punctures especially on lateral margins, punctures becoming much sparser and much weaker towards mid-line where they are barely discernible; second metasomal tergum with many, dense, fine, shallow punctures giving surface a roughened appearance, punctures much more dense than those on first metasomal tergum.

*Distribution:* The species is broadly distributed over America east of the Rocky Mountains and into the lowland areas of Utah, Idaho, and British Columbia. Marginal localities include: Miami, Florida; Neal Gap, Georgia; Logansport, Louisiana; Sarita and Corrizo, Texas; Albuquerque, New Mexico; Lamar, Colorado; Goshen and Portage, Utah; Pingree, Idaho; Summerland, British Columbia; Omaha, Nebraska; Chicago, Illinois; Macalester, Indiana; Seaside Park, New Jersey; Willard, North Carolina. (Map 4.)

*Flight records:* March 30 to December 3 in the far south with the peak of the population occurring during August to the north. It appears as if there may be two generations per year in the south.

*Plant records: Amorpha canescens, Amphiachris, Cassia fasciculata, Heterotheca subaxillaris, Isopappus divaricatus, Medicago sativa, Melilotus alba, Prionopsis ciliata.*

The holotype of *mandibularis* from Georgia is in the collections of the British Museum (Natural History), London, England, and that of *similis* from Carlinville, Illinois, has not been located in spite of a thorough search. The type is entered in the Robertson catalogue as "19835 [Colletes] (albescens) similis type ♀ July 9, 1897" with "similis type" written in pencil.

## *Colletes solidaginis* Swenk

(Fig. 49)

*Colletes solidaginis* Swenk, 1905, Canadian Ent., vol. 38, p. 40; Brimley, 1938, Insects of North Carolina, p. 451; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 224.

This species was orginally described by Swenk from Nebraska, and present distributional records indicate that Nebraska may be its western limit. It is found across the northern states and Canada and extends down the eastern coast as far as New Jersey. The species is a sibling species of *mandibularis* and appears to replace *mandibularis* in the north; insufficient material from the central-eastern states does not permit us to speculate as to the extent of overlap. In the male the most significant character is the sparseness and minuteness of the punctures on the discs of the first metasomal tergum, the mesepisterna, and the mesoscutum. The seventh ventral plates differ slightly from those of *mandibularis* in that the hair bands in *solidaginis* occur about the basal and lateral edges, while those of *mandibularis* extend from lateral clumps about the apical or lower portions of the plates. The female has the abdomen sparsely but completely covered with deep ochreus to yellowish pubescence, rather than having the nonpubescent discal areas as in *mandibularis*. The pile of the head and face in the female is most often tinged with yellow but may tend to grey in some specimens.

*Male:* length 8 mm., wing length 5 mm.

Pile of face dense, particularly along inner orbital margins and on clypeus, ochreus to pale yellow; very little pile above antennal bases; vertex with a few yellow hairs in ocellar triangle and upper genal areas; pile of genal areas becoming ochreus behind compound eyes and pale grey to white on lower faces; mesoscutum with moderately dense covering of yellowish pile; scutellum with weak lateral and posterior fringes of long, yellow to ochreus pile; mesopleura sparsely covered with long, pale grey pile which becomes light ochreus above; metapleura with little to no pile; propodeum with lateral faces bare, dorsolateral and posterolateral margins with strong ochreus fringes, posterior face with a few, scattered, ochreus hairs; legs with short, ochreus pile, sparse and not distinctly plumose; first metasomal tergum with sparse covering of scattered, light ochreus pile, lateral fringes of first metasomal tergum short and moderately dense; metasomal terga with distinct apical fasciae strongly tinged with ochreus; discs of metasomal terga two to five

with strong covering of semierect, ochreus pile giving surface a light golden sheen; metasomal sterna with very weak apical fringes of light ochreus hairs.

Antennae short, flagellar segments barely longer than wide; malar spaces one-half as long as wide; clypeus weakly convex, closely punctured with fine punctures at base becoming scattered and striate on apical half which is shiny and shallowly striately punctate; vertex dull with a few coarse punctures. Prothoracic spines short, virtually absent; mesoscutum with very sparse, shallow, and minute punctures over surface, punctures about two to three puncture widths apart, interspaces shiny; scutellum with posterior half dull and rugosely punctate, anterior half shiny, impunctate; mesepisternum sparsely and shallowly punctate, punctures at least one puncture width apart on disc, becoming closer on dorsal surface, interspaces shiny; metapleural prominences strongly protuberant but with very narrow, testaceous rims, slightly concave beneath; propodeum with lateral faces shiny, basal area with shallow quadrate pits, not sloping sharply behind, posterior face weakly roughened and shiny; tegulae light ochreus hyaline; wings with dusky ochreus pubescence over surface, nervures light yellowish brown; legs black except tarsi which tend to light brown; posterior basitarsi four times as long as wide and with a weak, longitudinal median furrow on upper surface. First metasomal tergum with disc shiny, impunctate; discs of metasomal terga two and three shallowly folliculated giving surface roughened appearance; metasomal sterna with apical margins straight; seventh ventral plates much as in *mandibularis* but with a weak continuous band of pile across base of each disc (fig. 49).

*Female:* length 9-10 mm., wing length 5 mm.

Pile of face uniformly distributed about antennal bases and inner orbital margins, strongly tinged with yellow on upper portion of face; clypeus with moderate covering of light ochreus or yellowish pile which partially obscures surface; vertex with a few, deep yellow hairs in ocellar triangle; upper genal areas covered with bright yellow pile, becoming white to grey immediately posterior to compound eyes, almost pure white on lower surfaces; mesoscutum with dense covering of yellowish pile; scutellum with yellow pile on lateral margins and posterior half of disc; mesepisterna with sparse, pale gray pile on disc, dorsal surface of mesepisterna and posterior lobes of pronotum with strong ochreus to yellow pile; metapleura with abundant light ochreus pile on lower surfaces;

propodeum with some partially appressed pubescence along anterior and upper margins, dorsolateral fringes of long, ochreus hair, posterior face with a few, long, pale grey hairs; legs with pile short and sparse on first two pairs of legs, pale grey to ochreus, pile of posterior femora very long, curved, and plumose, that of posterior tibiae long, dense, but not plumose; metasomal terga one to three with discs sparsely covered with appressed, ochreus to yellowish pubescence, surface not completely obscured; first metasomal tergum with pubescence intermixed with longer, semierect or erect, yellow pile, most evident on anterior face; fasciae of metasomal terga one to four broad and weak, pubescence easily removed by rubbing and in many specimens may be rubbed from central portion of disc; metasomal terga four to six having pubescence sparser and semierect, not concealing surface; metasomal sterna without apical fasciae.

Antennae short, reddish brown apically, becoming darker basally; malar spaces one-eighth to one-fourth as long as wide; clypeus weakly convex, roughened with coarse, striate punctures over entire surface; vertex shiny with a few, sparse, weak punctures. Prothoracic spines short and sharp, virtually absent; mesoscutum dull, covered with dense, shallow, fine punctures, no more than one puncture width apart on disc, impunctate area small; scutellum with posterior half roughened and rugose, anterior half shiny, impunctate; mesepisterna with disc covered with weak, shallow punctures, punctures approximately one puncture width apart on disc with very shiny interspaces, punctures becoming more dense dorsally and more obscure posteriorly; metapleural prominences strongly protuberant with very narrow, brown rims, which curve ventrally at posterior edge, weakly concave beneath; propodeum with lateral faces shiny, basal area with distinct, shallow, quadrate pits, posterior face weakly papillated and shiny; tegulae light ochreus hyaline; wings with a dusky covering of sparse, ochreus pubescence, nervures light brown; legs deep reddish brown; posterior basitarsi five times as long as wide, with a shallow, longitudinal furrow on upper surface; hind tibiae with a weak, longitudinal furrow evident on dorsal posterior surface. First metasomal tergum with disc shiny impunctate; second and third metasomal terga with discs weakly folliculated with sparse follicles and shiny interspaces; metasomal sterna with apical margin straight.

*Distribution:* North Carolina: Raleigh; Swannanoa. New Jersey: Bamber; Brown's Mills; Camden County; Clifton. Massachusetts:

Chilmark; Forest Hills; Nantucket; Needham; Sagamore. Michigan: Gladwin County; Midland County. Illinois: Carlinville; DuBois; Meredosia; Olive Branch. Minnesota: Fort Snelling. Iowa: Iowa County. Nebraska: North Platte. (Map 4.)

*Flight records:* July 15 to September 9.

The holotype from Lincoln, Nebraska, is in the collections of the University of Nebraska.

### GROUP IX—*hyalinus*

### *Colletes hyalinus* Provancher

(Fig. 51)

This variable species is found throughout northern America and in the mountains along the western edge of the Great Plains. Two subspecies extend to the coastal regions of Oregon and California.

*C. hyalinus* closely resembles *C. lutzi* Timberlake but has much less pile, particularly on the thorax and abdominal terga.

*Male:* length 8 mm., wing length 5.75 mm.

Pile of face long, ragged, and pale grey, particularly over clypeus and supraclypeal areas; vertex with pile tawny to tinged with ochreus; upper genal areas with pile pale grey, becoming much longer and whiter below; mesoscutum and scutellum with abundant, long, erect, pale grey pile, occasionally a few darker hairs intermixed; mesepisterna with pile long, fine, pale grey above to white below; propodeum with weak fringes of long, white pile at upper lateroposterior margins, lateral and posterior faces with sparse, erect, pale grey pile; pile of legs very sparse, long, and white; first metasomal tergum with apical fascia weak, narrow, and white, lateral fringes not complete to apical fascia, discal area with abundant, long, fine, pale grey hairs; metasomal terga two to five with fasciae broader, weak, and white; metasomal sterna two to five with narrow fringes of pale grey pile on apical margin, fringes broadened medially.

Antennae long, reddish brown, flagellar segments one and one-fourth times as long as broad; malar spaces three-fourths as long as broad; clypeus weakly convex, rather densely and finely punctate over the basal two thirds, punctures becoming sparser and more striate apically; vertex dull, densely punctate. Prothoracic spines long and sharp, almost twice as long as width across bases; mesoscutum densely punctate over anterior one third and lateral margins, impunctate area small; scutellum erratically punctate over posterior three fourths, punctures one to two puncture widths apart,

becoming much closer and finer posteriorly; mesepisterna rather shallowly punctate, punctures one puncture width apart above, becoming sparser below; propodeum deeply pitted with quadrate pits, lateral and posterior faces dull and weakly rugose. First metasomal tergum variably punctate with shiny interspaces; metasomal sterna shiny, sparsely folliculated; seventh ventral plates as illustrated in fig. 51.

*Female:* length 9 mm., wing length 7 mm.

Pile of face pale grey, concentrated principally about antennal bases; vertex with a few sparse hairs tinged with yellow; upper genal areas with pile tinged with yellow, becoming longer, finer, and whiter below; mesoscutum with pile long, fine, and light ochreus, concentrated about anterior one third and lateral margins; scutellum with pile pale grey to light ochreus, clumped along the lateral and posterior margins; mesepisterna with pile long, fine, and white to pale grey; propodeum with long fringes of pale grey to light ochreus pile along upper lateroposterior margins, posterior face with abundant, erect, short, pale grey pile; pile of legs short and sparse on anterior two pairs, posterior legs with pile long, light ochreus, and plumose.

Antennae reddish brown, flagellar segments three-fourths as long as broad; malar spaces three-eighths as long as broad; clypeus weakly convex, finely punctate along lateral margins and weakly, rugosely punctate over basal one fourth and along median line, lateroapical margins sparsely punctate but dull; vertex densely punctate with shiny interspaces; fascial foveae narrow and depressed sharply dorsally, terminating at upper ends of compound eyes. Prothoracic spines long and sharp, approximately twice as long as width across base; mesoscutum densely punctate over anterior one third and lateral margins, impunctate area small; scutellum coarsely and densely punctate over posterior seven-eighths of surface, punctures contiguous except at anterior part of mid-line, where they tend to be two puncture widths apart; mesepisterna densely punctate with shallow punctures, punctures almost contiguous above to one puncture width apart below, interspaces shiny; propodeum deeply, quadrately pitted, lateral and posterior faces dull and roughened; wings weakly covered with light fulvous pubescence; legs deep brown to black; posterior basitarsi three and three-fourths times as long as broad. Metasomal terga shiny; metasomal sterna dull, finely folliculated.

### *Colletes hyalinus hyalinus* Provancher

(Fig. 51)

*Colletes hyalinus* Provancher, 1888, Addit. Faun. Canada Hymen., vol. 2, p. 303; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario, p. 132; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 210.
*Colletes cauponarius* Cockerell, 1929, Ann. Mag. Nat. Hist., ser. 10, vol. 4, p. 297; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 390.
*Colletes fraserae* Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 41 (new synonymy).
*Colletes nitidicaudus* Cockerell, 1929, Ann. Mag. Nat. Hist., ser. 10, vol. 4, p. 299; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 390.
*Colletes spurcus* Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 58; Cockerell, 1905, Psyche, vol. 12, p. 87; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; Cresson, 1928, Mem. Amer. Ent. Soc., no. 5, p. 64; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 390; 1951, Wasmann J. Biol., vol. 9, p. 210.

Timberlake (1951) places *spurcus* Viereck in synonymy with *hyalinus hyalinus*. This synonymy and also that of *fraserae* Swenk with *C. hyalinus* (*sensu lato*) are undoubtedly correct at the species level, but I question the synonymy of these two names with *C. hyalinus* (*sensu stricto*). *Spurcus* and *fraserae* both represent montane populations of this species and are the only mountain representatives known. While there are insufficient morphological characters to give *spurcus* subspecific rank in the present paper, it may eventually prove to warrant this designation.

This subspecies is found throughout the northern part of America from the eastern seaboard to the Rocky Mountains.

The males have the pile of the mesoscutum and scutellum long, rather sparse, and pale grey, very weakly tinged with light ochreus; tegulae light brownish hyaline; nervures light brown; first metasomal tergum sparsely but distinctly punctate, punctures two to four puncture widths apart; metasomal terga three to six with the discs having abundant, short, erect, deep fulvous to black pile.

The female has the pile of the face, mesoscutum, and scutellum sparse, tinged with ochreus, often completely removed from the facial regions; metasomal terga with fasciae absent, evident only as sparse patches of short, white pubescence, particularly laterally on terga three and four; tegulae brownish hyaline; nervures light brown; first metasomal tergum very finely and sparsely punctate, the punctures two to five puncture widths apart and of variable size.

*Distribution:* Throughout northern America. Peripheral localities are King's County, Nova Scotia; Hemmingford, Quebec; Calais, Maine; Wexford County, Michigan; Beltrami County, Minnesota; White Fox, Saskatchewan; Hot Springs, South Dakota; Whitehorse, Yukon; Lethbridge, Alberta; Ward, Leadville, Creede, Gilpin, Aspen,

Pingree Park, and Tennessee Pass, all in Colorado; Beulah, New Mexico. (Map 5.)

*Flight records:* This species has been recorded between June 24 and September 5, flying principally during the months of July and August.

*Plant records: Achillea, Cirsium, Epilobium, Kalmia, Melilotus, Solidago,* Sumac (*Rhus*), *Frasera.*

The holotype of *hyalinus* from Quebec is in the Quebec Public Museum, Quebec City, Canada; those of *cauponarius* and *nitidicaudus* from Long's Peak Inn, Colorado, are in the Citrus Experiment Station, Riverside, California; that of *fraserae* from Beulah, New Mexico, is in the University of Nebraska collections; and that of *spurcus* from Beulah, New Mexico, is in the Academy of Natural Sciences of Philadephia.

### *Colletes hyalinus oregonensis* Timberlake

*Colletes hyalinus oregonensis* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 211.

This subspecies occupies the coastal regions of Oregon and northern California.

The male differs from *hyalinus* in having pile longer and whiter over entire body; malar spaces as long as broad; first metasomal tergum with punctures fine and separated by two to four puncture widths; seventh ventral plates with weak apical median emarginations.

The female is as in *hyalinus* but has the pile longer and more pale grey on the thorax; metasomal terga with apical fasciae much more evident and rather broad on terga two to four; first metasomal tergum with long, dense lateral fringes of pile; clypeus more densely punctate with weak striate punctures almost to apex; first metasomal tergum with punctures fine and sparse, tergum almost folliculated rather than punctured.

*Distribution:* Fifty miles south Waldport, Oregon, July 14, 1937; Newport, Oregon, September 7, 1929 (H. A. Scullen); Newport, Oregon, June 8, 1925; Coos County, Oregon, July 3, 1926; North Bend, Oregon, June 24, 1934; Florence, Oregon, June 29, 1941; Crescent City, California, July 13, 1937; mouth of Redwood Creek, Humboldt County, California, July 11, 1937; Crick, Humboldt County, California, July 5, 1931; all of this material unless otherwise noted was collected by E. C. Van Dyke. (Map 5.)

Two specimens, a male taken at Rolla, British Columbia, and a

female from Metaline Falls, Washington, appear to be intermediate between *h. hyalinus* and *h. oregonensis,* but resemble *h. hyalinus* more closely. If these two are representatives of an intermediate form between the two subspecies there is possibility of intergradation in the valleys of the northern Cascade regions.

The holotype is in the collections of the Citrus Experiment Station, Riverside, California.

### *Colletes hyalinus gaudialis* Cockerell

*Colletes gandialis* (*sic*) Cockerell, 1905, Bull. So. Cal. Acad. Sci., vol. 4, p. 32.
*Colletes gaudialis,* Cockerell, 1905, Bull. So. California Acad. Sci., vol. 4, p. 106 (correction of *gandialis*); 1905, Psyche, vol. 12, p. 86; 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 425; Bray, 1917, Pomona J. Ent. Zool., vol. 9, p. 99; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 392; 1951, Wasmann J. Biol., vol. 9, p. 212.
*Colletes californica* Viereck (not Provancher), 1903, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 730.
*Colletes arenicola* Cockerell, 1926, Ann. Mag. Nat. Hist., ser. 9, vol. 18, p. 626; 1933, Ann. Ent. Soc. Amer., vol. 26, p. 43.

Although evidence for the placement of *gaudialis* as a subspecies of *hyalinus* is not as yet conclusive, I agree with Timberlake that it is sufficiently similar to *h. hyalinus* to rank as a subspecies. This form is more densely and coarsely punctate than *hyalinus* in both sexes. *C. h. oregonensis,* with which *gaudialis* intergrades along the northern California coast, is intermediate between *hyalinus* proper and *gaudialis.*

The male differs from *hyalinus* in having the pile of thorax and abdomen much longer and denser; malar spaces three-fourths as long as broad; first metasomal tergum very closely and densely punctate, punctures no more than one puncture width apart.

The female differs in having pile of face long, dense, and pale grey about antennal bases and inner orbital margins; vertex, mesoscutum, and scutellum with pile long, dense, and pale grey, tinged with ochreus; metasomal terga with dense, broad apical fasciae of pure white pubescence; first metasomal tergum with dense, long lateral fringes extending to apical fasciae, discal area with abundant, long, erect, white pile; clypeus densely punctate, shiny with punctures striate, extending almost to apex, even at median line; first metasomal tergum with punctures coarse, indistinct, approximately two puncture widths apart.

*Distribution:* The species occurs along the California coast from San Diego north at least as far as Marin County and has been recorded inland at Hemet and Riverside in southern California as well as Woodlake and Lindsay in Tulare County, Mendota in Fresno County, and Tracy in San Joaquin County. (Map 5.)

*Flight records:* The species has been recorded from April 19 to September 24 and occurs during all of the summer months.

*Plant records: Asclepias, Baccharis, Eriogonum, Gutierrezia, Heliotropium, Hemizonia, Isocoma, Melilotus, Oenothera, Solidago.*

The holotype of *gaudialis* from La Jolla, California, is in the Academy of Natural Sciences at Philadelphia, and that of *arenicola* from Pacific Grove, California, is in the United States National Museum.

### *Colletes lutzi* Timberlake

(Fig. 52)

The species is very difficult to distinguish from *C. hyalinus,* especially in the southern areas of California. Generally the pubescence is denser, shorter, and usually paler on the thorax and abdomen, and the puncturation of the abdomen usually coarser on the first two metasomal terga. The mesepisterna have the punctures of the upper face sparser, nonrugose, and with shiny interspaces. (In *hyalinus* the upper parts of the mesepisterna tend to be striately punctate.)

The males of the species differ from *hyalinus* in having somewhat shorter malar spaces, being not nearly as long as wide, and in having the seventh ventral plates emarginate apically. The lateral hair bands of the seventh ventral plates are weakly developed and not broadly united to the median band basally, and the pile of this lateral band is very much shorter, tending to be more appressed, than in typical *hyalinus.*

The close resemblance of this species to *hyalinus* suggests the possibility that the two species may intergrade or hybridize at one point or another. However, I have seen no material which would substantiate this hypothesis.

The species occurs in the mountainous regions from Colorado about the northern edge of the Great Basin into Washington, thence along the mountains into southern California, and to my knowledge is not found below 4000 feet. There is a great deal of variation in the species throughout the range as well as in individual populations, thus making recognition of subspecies rather difficult. Little variation exists in the males from Colorado to California; however, a few males from Oregon reach the length of 8 mm. There is some variation in the puncturation of the first metasomal tergum, particularly in specimens from the mountains of California, but these regional differences are not constant and equal variation appears to occur within local populations.

In the females, evidence of subspeciation is much more distinct, principally in the amount of appressed pubescence on the discs of metasomal terga two to five.

*Male:* length 6 to 8 mm., wing length 4.75 to 5.5 mm.

Pile of face long and dense, particularly about antennal bases and over clypeus, clypeus completely concealed; pile of vertex and upper genal areas sparse, long, and all light, pile becoming longer and whiter below; mesoscutum with pile long, fine, and dense; scutellum with a lateral and posterior fringe of long, fine, white to dusky pile; mesepisterna with pile long, fine, and pale grey to pure white; propodeum with dense fringes of long, pale grey to whitish pile, particularly on lateroposterior margins, fringes most dense on dorsal surfaces; pile of legs sparse and white; first metasomal tergum with apical fascia dense and broad, lateral fringes of pile long and dense reaching to apical fascia, disc with abundant, long pile, not concealing surface; metasomal terga two to five with fasciae broad, dense, and complete to extreme lateral margins; metasomal terga three to six with discs having abundant, long, erect, pale grey to light yellowish pile, a few, darker, short hairs intermixed; metasomal sterna two to four with apical fasciae broad, dense, and pale grey to white, broadened medially.

Antennae long, dark brown to black, flagellar segments one and one-half times as long as broad; malar spaces three-fourths to seven-eighths as long as broad; clypeus long, convex, with a very weak longitudinal median sulcus, basal portion very finely and densely punctate, punctures almost contiguous, becoming more striate on apical and lateroapical margins; vertex dull, very deeply, coarsely, and densely punctate, punctures almost contiguous. Prothoracic spines small, very sharply pointed, fully as long as the width across the base; mesoscutum variably punctate, impunctate area large; mesepisterna with punctures approximately one-half puncture width apart, becoming sparser below and towards posterior margins, interspaces shiny; propodeum with basal area irregularly, not quadrately pitted, dull, with abundant longitudinal rugae, narrow elongate pits obscure; legs deep brown to black; posterior basitarsi long and slender, approximately four and one-half times as long as broad. First metasomal tergum very densely, deeply punctate, with shiny interspaces, punctures no more than one-half puncture width apart; second metasomal tergum with punctures much closer and just appreciably finer, tergum sharply depressed basally; metasomal sterna shiny, very finely and sparsely folliculated; seventh ventral plates

sharply emarginate apically, lateral hair bands of seventh ventral plates weakly developed and not broadly united to median band basally, pile of lateral band short and tending to be somewhat appressed rather than erect form as in *hyalinus* (fig. 52).

*Female:* length 8 to 9 mm., wing length 5.5 to 6 mm.

Pile of face long and rather dense about antennal bases and towards inner orbital margins; vertex with pile long, erect, and rather dense in ocellar triangle, dusky to tinged with light ochreus; upper genal areas with pile short, rather dense, and erect, pale grey, occasionally tinged with light ochreus, becoming much longer and whiter below, a broad fringe of appressed, white pubescence immediately posterior to each compound eye; mesoscutum with abundant, dense, pale pile about anterior one third and lateral margins, pile becoming sparser over median discal area; scutellum with a broad fringe of pale pile about lateral and posterior margins; mesepisterna with pile long, fine, dense, pale grey to pure white; propodeum with long fringes of pale grey to dusky pile on lateroposterior margins, fringes longest and most dense on dorsal surfaces, lateral and posterior faces with a sparse covering of erect, pale pile; anterior two pairs of legs with pile sparse, short, and white, pile long, dense, and extremely plumose on posterior legs, pale grey to tinged with yellowish; first metasomal tergum with apical fascia distinct, lateral fringes of long, white pile dense and extending to apical fascia; metasomal terga two to five with fasciae broad, dense, white to tinged occasionally with yellow; second metasomal tergum with a broad basal fascia; metasomal sterna virtually bare.

Antennae reddish brown to deep brown, flagellar segments about as long as broad; malar spaces one-third as long as broad; clypeus weakly convex, tending to be somewhat flattened medially, very coarsely and irregularly punctate, punctures most dense about basal and frontoclypeal margins, with disc irregularly punctate with shiny interspaces; vertex coarsely and densely punctate, dull; fascial foveae very narrow, extending along upper inner orbital margins to points just above dorsal inner orbital margins. Prothoracic spines long and sharp, at least one and one-half times as long as width across base; mesoscutum rather coarsely and densely punctate over extreme anterior and lateral margins, impunctate area large; scutellum densely punctate about extreme lateral and posterior margins, punctures becoming very sparse over the median discal area, anterior one third shiny, impunctate; mesepisterna with punctures much as those of mesoscutum, punctures one-half to one puncture width

apart, separated by shiny interspaces, punctures becoming finer and sparser below and on the posterior ventral surfaces; propodeum with basal area very shallowly and somewhat obscurely pitted, pits irregular in size, lateral and posterior faces very weakly roughened and dull; wings dusky; legs deep brown to black; posterior basitarsi long, four times as long as broad. First metasomal tergum strongly punctate, punctures becoming much finer on metasomal tergum two; metasomal sterna two to five shiny, very finely and sparsely folliculated.

This species is divided into four subspecies as follows.

### *Colletes lutzi lutzi* Timberlake

*Colletes lutzi* Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, pp. 390-1.

This subspecies is the smallest of the group, occurring in the mountains to the east and northeast of the Great Basin. Only females with the metasomal terga one to four more than half covered with appressed pubescence are designated as *lutzi*, and only in the females are the subspecific characters evident. The typical specimens of *l. lutzi* from Colorado have the abdominal terga completely covered with appressed pubescence. A number of specimens taken at Granger, Wyoming, vary in this respect, one specimen having the abdomen as in the typical *lutzi* while four others have small, narrow, nonpubescent bands between the basal and the apical fasciae.

The male has the pile of the face long, dense, and white; vertex with pile dusky; mesoscutum and scutellum with pile long, sparse, and ragged, pure white to pale grey; metasomal terga with pile of apical fasciae and pile covering first metasomal tergum long, dense, and pure white; mesoscutum very finely and sparsely punctate, punctures one to two puncture widths apart on anterior and lateral faces, impunctate area very large; scutellum with discal area shiny, very sparsely punctate, punctures occurring only on posterior two thirds and then one to three puncture widths apart; tegulae light hyaline; wings with a sparse covering of light fulvous pubescence, nervures light brown; first metasomal tergum finely and densely punctate, punctures one to one and one-half puncture widths apart.

The female has the vertex with pile white to tawny; mesoscutum with pile pale grey, pile concentrated principally on anterior and lateral margins, with a broad, nonpilose discal area; scutellum with pile long, fine, and pale grey; first metasomal tergum with disc having abundant, appressed, white pubescence, reaching apical fascia;

metasomal terga two to four with broad basal fasciae, fasciae at least covering one half of the discal area (in a few specimens the entire discal area is completely covered with appressed, whitish pubescence); clypeus with apical and apicolateral margins shiny, sparsely punctate with a few coarse punctures; mesoscutum finely and rather densely punctate over anterior and lateral margins, punctures one-half to one puncture width apart, impunctate area large; scutellum with anterior one-half shiny, virtually impunctate; tegulae light hyaline brown; wings dusky with a very weak covering of light fulvous pubescence, nervures light brown; first metasomal tergum finely punctate, punctures one to three puncture widths apart; second metasomal tergum shiny, coarsely folliculated.

*Distribution:* New Mexico: 14 mi. NW Atarque. Colorado: Florissant; Grand Junction; Aspen; Great Sand Dunes National Monument; Fort Garland; Ute Creek; Antonito; Maybell; Lay; Eckert; Creede; Larimer; Cripple Creek; Greeley. Wyoming: Cheyenne; Granger; Bridger Basin. Montana: Bozeman. Utah: Clover; Willow Creek; McCormick; Parowan; Erda; Randolph; Kelton; Lakeview; Nodina; Petersboro; Logan; Emery County. Idaho: Fort Hall; Castleford; Hollister; Hagerman; Tuttle; Kimama; Milner; Buhl; Oakley; Adelaide; Roseworth; Jerome. (Map 6.)

There is one additional specimen taken from Box Butte County, Nebraska, which appears to belong with this subspecies.

In addition a few specimens taken from the extreme eastern portion of Oregon in the vicinity of Lapin and Milton very closely resemble this subspecies and probably represent an area of intergradation between *l. lutzi* and *l. interior.*

*Flight records:* This subspecies has been recorded as flying between June 10 and August 27.

*Plant records: Chrysothamnus, Cleome serrulata, Melilotus.*

The holotype of this subspecies from Leadville, Colorado, is in the American Museum of Natural History.

### *Colletes lutzi interior* Timberlake

*Colletes monticola interior* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 214.

In the description of *monticola interior* Timberlake states that it has the punctures of the first tergum "just appreciably finer and sparser" than in *m. monticola.* This is so in a few specimens, but in others from the same area the puncturation is as coarse as, or even coarser than, in typical *monticola.* However, the tegulae are lighter in *interior* and the discal pubescence of the terga tends to a

deep ferrugineous rather than the black of *monticola.* From the typical series the description indicates a well-developed basal band or fascia on tergum two and sometimes also on tergum three. In this description Timberlake apparently omitted the specimens from Craters of the Moon, Idaho, and Bend, Oregon, which have well-developed bands on terga two and three and an incomplete or weak band on the fourth metasomal tergum. The female from Craters of the Moon, Idaho, is more typical of the *l. lutzi* populations and undoubtedly represents an intermediate form between this and *l. interior.* The male of *interior* differs very slightly from *monticola* and *lutzi.*

As here understood, the range of *interior* extends from the type locality, Reno, Nevada, northward into Oregon, Washington, and western Idaho. Timberlake had a number of specimens in his possession which were classified with typical *monticola* but which exhibit some intergradation with certain characters of the subspecies *m. interior.* These seem to be an intermediate form between the *monticola* from central California and the *interior* from eastern and northern California and central Oregon, having distinct basal fasciae on metasomal terga two and three and in some cases even four.

The male has the pile of mesoscutum and scutellum dusky to tinged with light ochreus; metasomal terga having fasciae broader, denser, and pure white; first metasomal tergum with pile of disc long, fine, and white, dense and barely obscuring surface; clypeus more densely punctate than in *l. lutzi,* punctures extending two thirds of way down towards the apex, apex and apicolateral portions shiny and sparsely punctate; mesoscutum with punctures dense about anterior and lateral margins, punctures no more than one puncture width apart, impunctate area large; scutellum with the lateral and posterior margins densely punctate, contiguous, and becoming sparser and coarser on discal area, anterior one fourth shiny, impunctate; tegulae brownish hyaline; wings dusky with abundant, light fulvous pubescence, nervures brown; propodeum with basal area more deeply pitted than in *l. lutzi,* pits not uniformly quadrate; first metasomal tergum finely and densely punctate, punctures no more than one puncture width apart.

The female has the pile of face sparse and concentrated about the antennal bases; vertex with pile pale grey to tinged with light ochreus; mesoscutum and scutellum with pile long and dense about anterior, lateral, and posterior margins, median discal areas non-

pilose, pile dusky to tinged with light ochreus; first metasomal tergum with apical fascia white, somewhat weakened medially, lateral fringes of long, white pile dense extending to apical fascia, disc with intermixed appressed and erect, whitish pile, concealing no more than half of discal area of first tergum; metasomal terga two to five with apical fasciae broad, dense, and white; second metasomal tergum with a broad, dense, white basal fascia; metasomal tergum three usually with a very narrow basal fascia of white pile; clypeus convex, sparsely punctate over median discal area, with punctures shallow yet coarse; mesoscutum densely and coarsely punctate over the anterior and lateral margins, punctures almost contiguous; scutellum with median discal area coarsely, tending to be weakly striately punctate, anterior one fourth shiny, impunctate; tegulae brownish hyaline; wings dusky with abundant fulvous pubescence, nervures brown; first metasomal tergum rather densely punctate, punctures becoming very fine and sparser medially, punctures one to two puncture widths apart, interspaces shiny; second metasomal tergum with disc finely and rather densely follicULated, dull.

*Distribution:* California: Hallelujah Junction, Lassen County; Alta Meadow; Sierraville, Sierra County (paratype). Nevada: Fallon; Reno (paratype); Lovelock (paratype); Sparks (paratype). Oregon: Mount Hood; Whitewater Ridge; High Ridges; Parkdale; Sisters; Bend; Lake of the Woods, Klamath County; Tumalo; Des-Chutes County; Lakeview; Chiloquin; Cloverdale; The Dalles; Hood River; Milton; Redmond; Prineville; Sandy River (paratype); Bend (paratype). Washington: White Rock Spring; Wawawai; Colokum Pass. Idaho: Craters of the Moon (paratype). (Map 6.)

*Flight records:* The subspecies has been recorded as flying between the 20th of June and the 6th of September, occurring predominantly during July and August.

*Plant records: Melilotus alba.*

The types of this subspecies are in the collection of the California Academy of Sciences.

### *Colletes lutzi monticola* Timberlake

*Colletes monticola monticola* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 212.
*Colletes monticola inyoensis* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 215 (new synonymy).

Through the courtesy of P. H. Timberlake, who has lent his typical series of *lutzi* for study, I find that *C. monticola* intergrades

rully with *C. lutzi* along the northern outskirts of the Great Basin. Timberlake suspected this in saying, "It is possible that on the eastern and northern outskirts of the Great Basin *monticola* may occur and there intergrade with *lutzi*." However, in spite of two specimens from Bend, Oregon, and Craters of the Moon, Idaho, he apparently did not feel that he had sufficient material to warrant making *monticola* a subspecies of *lutzi*.

The subspecies *m. inyoensis* Timberlake described from females taken at Big Pine and Bishop, Inyo County, is an intermediate form between the subspecies *monticola* and *interior* and does not seem to me to merit subspecific rank. The puncturation of the first metasomal tergum is intermediate between that of *interior* and *monticola*, there is a very weak basal band on tergum three, the discal areas of terga three to six are covered with the deep ferrugineous to dark brown, erect pubescence typical of *interior*, and the tegulae are an intermediate amber color between *monticola* and *interior*. Equal or greater variation can be discerned in populations of *l. monticola*, and *inyoensis* is therefore placed in the synonymy of that subspecies.

The typical series of *monticola* has a basal fascia on the second metasomal tergum, while on terga three and four the fasciae are absent or barely discernible laterally; the puncturation of the first metasomal tergum is rather sparse but distinct in most of the range, becoming coarser and much denser in the material from the southern mountains of California, reaching its peak in *m. pinorum* from the San Bernardino and San Jacinto Mountains; the pubescence of the thoracic terga and the vertex of the head is a yellow ochreus in the southern limits of California, becoming pale ochreus in northern California and tawny grey to white throughout the northern and eastern extent of the range.

The male has the vertex with pile dusky to tinged with ochreus; mesocutum and scutellum with a dense covering of long, erect, dusky to light ochreus pile; metasomal terga one to five with the apical fasciae very broad, dense, and white; first metasomal tergum with the lateral fringes of long, white pile extending to the apical fascia, disc with abundant, erect, white pile, partially obscuring surface; clypeus finely and densely punctate over basal three fourths, punctures extending almost to apex along a median longitudinal line; mesoscutum coarsely and densely punctate over anterior and lateral faces, punctures contiguous to one-half puncture width apart; scutellum with discal area sparsely and finely punctate, punctures

one to three puncture widths apart, anterior one fourth shiny, impunctate; tegulae brownish hyaline; wings dusky with abundant, deep fulvous pubescence, nervures dark brown; propodeum with basal area dull with numerous, elongate, narrow pits, pits shallow; first metasomal tergum densely and rather coarsely punctate, punctures becoming finer and slightly sparser medially, punctures no more than one puncture width apart; second metasomal tergum finely and densely punctate, punctures one-half puncture width apart, with shiny, linear interspaces.

The female has the pile of face and vertex tinged with light yellow; mesoscutum and scutellum with pile long, dense, and tinged with light ochreus; first metasomal tergum with apical fascia weak and whitish, the disc with an admixture of appressed and erect, whitish pile, concealing only extreme anterior portion of disc; metasomal terga two to four with apical fasciae broad, dense, and white; second metasomal tergum with a broad basal fascia of pure white pubescence; metasomal tergum three with a very faint trace of a basal fascia; clypeus shiny black, coarsely and striately punctate, particularly over basal two thirds and lateral margins, median apical portion shiny, impunctate; mesoscutum very densely and coarsely punctate over anterior one half and lateral margins; scutellum shiny, sparsely and finely punctate; tegulae deep brown hyaline; wings dusky with abundant, deep fulvous pubescence, nervures dark brown; first metasomal tergum densely punctate, punctures one-half to one puncture width apart; second metasomal tergum finely and densely punctate, punctures approximately one puncture width apart.

*Distribution:* California: Log Meadow, Sequoia National Park; Wolverton Creek, Sequoia National Park; Dorst Camp, Three Rivers and Mineralking, Tulare County; Huntington Lake, Paradise Valley, near Nellie Creek, and Bubbs Creek, Fresno County; Grant Lake, Mammoth and Deadman's Creek, Mono County; Lone Pine and Bishop, Inyo County; Lake Tahoe; Carson Pass. (Map 6.)

*Flight records:* The subspecies flies from June 1 to September 11.

*Plant records: Castanopsis; Chrysothamnus; Solidago elongata.*

The holotype of *monticola* from Log Meadow, Sequoia National Park, California, is in the Citrus Experiment Station, Riverside, California, and that of *inyoensis* from Big Pine, Inyo County, California, is in the California Academy of Sciences.

### *Colletes lutzi pinorum* Timberlake

*Colletes monticola pinorum* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 215.

This subspecies represents the southern known extremity of *lutzi* and differs from the *l. monticola* only in the coarser and closer puncturation of the abdomen, especially tergum one. There is a very faint trace of a basal fascia on metasomal tergum three in females from Pine Knot, which is not discernible in females from Hemet Reservoir. The puncturation referred to is coarser and closer in the Hemet specimens but the subspecies approaches *l. monticola* in the females from Pine Knot. The puncturation of the first metasomal tergum in the males is coarser and denser than *l. monticola.*

The male is much as in *monticola* except in having the clypeus a little more coarsely punctate; first metasomal tergum more densely and deeply punctate, punctures contiguous to one-half puncture width apart; second metasomal tergum with punctures almost contiguous on anterior and median portions; metasomal tergum three deeply and rather densely punctate, punctures no more than one-half puncture width apart.

The females are as in *monticola* except in having the clypeus coarsely and densely punctate over basal half and striately punctate to apex; first metasomal tergum dull, very densely and deeply punctate, punctures one-half to one puncture width apart; second metasomal tergum finely and densely punctate, contiguous towards anterior margins where punctures are much finer, dull; metasomal tergum three very finely and densely folliculated, surface dull.

*Distribution:* California: Keen Camp (holotype and allotype), Hemet Reservoir and Idyllwild in the San Jacinto Mountains; Bear Valley, Pine Knot, South Fork Camp, Rathbon Creek and Big Bear Lake in the San Bernardino Mountains. (Map 6.)

*Flight records:* The subspecies has been recorded from June 10 to September 10.

*Plant records: Aster; Cryptantha; Eriogonum molestum* var. *davidsonii; Gnaphalium thermale; Hemizonia wheeleri; Layia platyglossa.*

The types of this subspecies are in the Citrus Experiment Station, Riverside, California.

## *Colletes distinctus* Cresson

(Fig. 53)

*Colletes distinctus* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 167; Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 115; Cockerell, 1905, Psyche, vol. 12, p. 87; Cresson, 1916, Mem. Amer. Ent. Soc., no. 1, p. 107; Graenicher, 1930, Ann. Ent. Soc. Amer., vol. 23, p. 154.
*Colletes banksi* Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 19 (new synonymy).
*Colletes ilicis* Mitchell, 1951, J. Elisha Mitchell Sci. Soc., vol. 67, p. 234 (new synonymy).

The species is a member of the *hyalinus* group found in the eastern United States from Florida to Michigan. The male differs from *hyalinus* in having the posterior and lateral faces of the propodeum deeply and rugosely pitted with shiny surfaces, the mesepisterna rugosely punctate, the malar spaces one-half as long as wide, and the first metasomal tergum sparsely folliculated. In the females the last metasomal sternum has raised lateral longitudinal ridges converging apically. The present work extends the range to Michigan, New York, and North Carolina.

*Male:* length 9 mm., wing length 7 mm.

Pile of face long, dense, and tinged with ochreus completely covering clypeus; pile of vertex sparse, light ochreus with no dark pile intermixed; pile of the mesoscutum tawny to tinged with light ochreus, erect and with no black hairs but a few deeper ochreus hairs intermixed particularly on median surfaces; scutellum covered much as the mesoscutum; pile of mesopleura long, erect, plumose, and pale grey; propodeum with rather dense clumps of long, light ochreus pile along dorsolateral margins; legs with the pile short, a pale grey to very light ochreus, not at all concealing surface; metasomal fasciae weak and very slightly tinged with light ochreus; first metasomal tergum with a lateral fringe of pile extending down to apical fascia, a few, erect, pale grey hairs on disc; metasomal sterna with apical fasciae composed of weak fringes of light ochreus pile becoming very weak medially.

Antennae long, deep brown, flagellar segments one and one-half times as long as broad; malar spaces one-half as long as broad; clypeus weakly convex, densely punctate over basal one half, tending to be striately punctate apically; vertex very closely and densely punctate, dull. Prothoracic spines long and sharp, approximately one and one-half times as long as width across base; mesoscutum coarsely punctate with shiny interspaces; punctures not at all rugose, impunctate area small; scutellum very coarsely punctate, not striate, a weak longitudinal median sulcus extending length of scutellum;

mesepisterna very coarsely, rugosely punctate, almost appearing pitted on upper surfaces, punctures becoming sparser and finer below; metapleuron very rugosely pitted on upper one half; propodeum deeply and densely pitted over lateral and posterior faces, pits shiny, basal area with deep, shiny, quadrate pits; tegulae brown; wings with testaceous pile giving them a dusky appearance, nervures brown to deep brown; legs a deep reddish brown; posterior basitarsi four times as long as broad. First metasomal tergum shiny with a few sparse follicles becoming slightly denser laterally where they are in densest area no less than three to four follicle widths apart, apical margins of metasomal terga weakly depressed, most evident laterally and tend towards hyalineness; seventh ventral plates much as in *hyalinus,* however slightly broadened on lateral aspects and with narrow nonplumose, nonpilose, testaceous rims laterad of descending hair bands (fig. 53).

*Female:* length 11 mm., wing length 7.5 mm.

Face with sparse, light pile, not at all concealing surface; a few pale grey hairs in ocellar region of vertex, a few, appressed, short, white hairs medially posterior to compound eyes, hair becoming much longer and more erect on lower surface of genal areas; mesoscutum and scutellum with pile rather short, pale grey, no evidence of black hairs intermixed; mesepisterna with pile long, plumose, and rather sparse; pile of legs sparse and pale grey to light ochreus except on posterior tibiae and tarsi, where a few darker, almost black, hairs are intermixed on upper surfaces; metasomal tergum one with a very weak apical fascia, evident only laterally, a rather weak fringe of short, white pile extending almost to apical fascia; terga two to five with fasciae tending to become broader and more dense, pile pure white; metasomal terga four to six with disc covered with semierect, deep ochreus pile; sternal fasciae absent except for a few, sparse, long hairs on apical half of disc.

Antennae long, deep brown, flagellar segments about as long as wide; malar spaces one-third as long as broad; clypeus weakly convex and striately punctate to apex; vertex rather deeply and coarsely punctate with shiny interspaces; fascial foveae deep and uniformly broad to vertex where upper ends reach two thirds of way to lateral ocelli. Prothoracic spines triangular forming roughly equilateral triangles; mesoscutum densely punctate over anterior one-half and lateral margins, impunctate area large and shiny; scutellum with punctures much coarser than those on mesoscutum, not striate; a weak longitudinal median sulcus extending length of

scutellum; mesepisterna, as in male, coarsely, rugosely punctate on upper surfaces, becoming sparser below, with shiny interspaces; propodeum with basal area deeply pitted with elongate, quadrate pits, upper surface of lateral and posterior faces very deeply, rugosely pitted, pits becoming shallow or absent on lower portions; tegulae deep brown, nervures deep brown, wings with surface dusky to testaceous, having abundant, short, brown pile concentrated principally at apical ends; legs dark black, posterior tibiae with a weak, shallow, longitudinal excavation on upper posterior surface; posterior basitarsi three times as long as broad. Metasomal terga shiny, impunctate, a few follicles about extreme apical margin of first metasomal tergum; metasomal terga two to five shiny black with a few sparse follicles on discal area; metasomal sterna with a very weak, hyaline rim at apex of sterna two to five, discal areas indistinctly punctate; last metasomal sternum with weak lateral elevated longitudinal ridges converging apically but not meeting.

*Distribution:* Michigan: Sand Point, Huron County; Lake County; State Game Refuge, Tosco County. New York: Mosholu. New Jersey: Ramsey. North Carolina: Ivanhoe; Holly Shelter; Spout Springs. South Carolina: McClellanville. Georgia: Ga. (paratype); Bartow. Florida: Jacksonville; Crescent City. (Map 5.)

*Flight records:* April 12 to July 21.

*Plant records: Ilex glabra.*

The lectotype of *distinctus* from Georgia is in the Academy of Natural Sciences of Philadelphia, that of *banksi* from Falls Church, Virginia, is in the University of Nebraska collections, and that of *ilicis* from Ivanhoe, North Carolina is in the collection of T. B. Mitchell, Raleigh, N. C.

Although Swenk states that the species was described from a single specimen, this is not indicated in the original description and a lectotype as well as apparently valid "paratypes" are in the collections at Philadelphia.

### *Colletes phaceliae* Cockerell

(Fig. 54)

*Colletes phaceliae* Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 315; 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 18, p. 74; 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 424; 1907, Univ. Colorado Studies, vol. 4, p. 240; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario, p. 132; Cockerell, 1931, Amer. Mus. Nov., no. 397, p. 5; 1933, Ann. Ent. Soc. Amer., vol. 26, p. 43; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 388.

*Colletes salicicola geranii* Cockerell, 1906, Canadian Ent., vol. 38, p. 163; 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 424; 1907, Univ. Colorado Studies, vol. 4, p. 240; Gibson and Criddle, 1911, Rept. Ent. Soc. Ontario

for 1910, p. 117; Cockerell, 1911, Canadian Ent., vol. 43, p. 33; 1919, Canadian Ent., vol. 51, p. 27; 1930, Amer. Mus. Nov., no. 397, p. 5; 1933, Ann. Ent. Soc. Amer., vol. 26, p. 43; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 388.

This species occurs in the western portion of the Great Plains, through the northern parts of the mountains into eastern Washington and Oregon as well as in the valleys of southern British Columbia. The males can readily be distinguished in having very long malar spaces, usually as long as wide, and in having the basal area of the second metasomal tergum strongly depressed with long white pile in the form of a weak, although not appressed, basal fascia. The females are easily confused with *lutzi*, from which they can be distinguished only with difficulty. *C. phaceliae* is larger, 9.5 to 10.5 mm., and has the malar spaces one-third as long as wide; specimens from Utah, Idaho, Washington, and Alberta have the abdominal terga covered much as in *lutzi*, but generally the pile is much coarser and most sparse at the extreme lateral portions of each disc. In *lutzi* the females rarely exceed 7.5 mm. in length, although a few do reach 8 mm.; the malar spaces are shorter, one-fourth as long as broad; and the metasomal terga are covered with fine white pile which tends to be most dense and most extensive at the lateral extremities of each disc.

Considerable variation exists in the species over its wide range. The males from the most easterly regions have the puncturation of the first metasomal tergum fine, with punctures approximately two puncture widths apart, while in specimens from the far west the punctures are denser and coarser, no more than one puncture width apart in some.

In the females the pattern of metasomal pubescence undergoes the greatest variation. Those occurring in the western Great Plains are invariably more sparsely covered than those found in the northwestern states. Specimens having the minimum coverage observed among over 700 specimens examined have the first, second, and third metasomal terga each with the basal one half of the prefascial portion concealed by appressed white pubescence. The basal and apical fasciae of each tergum are approximately the same width. Maximum pubescent covering was observed on two females from Washington, which have the discs of the metasomal terga one to four completely concealed by appressed white pubescence. Various intergradations between these two extremes have been examined and it is difficult, if not impossible to establish an intelligible cline,

although generally the amount of appressed pubescence increases in the north and northwestern portions of the range.

*Male:* length 8.5 mm., wing length 6 mm.

Face with pile very long, dense, and pure white, tending to semi-appressed along inner orbital margins, completely concealing clypeus; vertex with pile white to tawny; genal areas with pile dense, long, and pure white, a weakly appressed rim just posterior to compound eyes; mesoscutum with pile pure white; scutellum with pile long, dense, and weakly plumose; mesepisterna with pile long, fine, and pure white; propodeum with weak lateroposterior clumps of pile barely distinguishable from long, white, erect pile covering on lateral and posterior faces; legs with pile long, sparse, and pure white; metasomal terga one to six with very broad apical fasciae of pure white pubescence; first metasomal tergum with strong lateral fringes of white pile, anterior face and disc with abundant, long, erect, white pile; second metasomal tergum with basal area having abundant, shorter, white, erect hairs, forming a very weak basal fascia in depression; metasomal terga three to six with discs having shorter, erect, white pile, giving surface whitish sheen; metasomal tergum seven with pile light ochreus and appressed; metasomal sterna two to four with broad, dense apical fasciae slightly broadened medially.

Antennae long, reddish brown, flagellar segments one and one-half times as long as broad; malar spaces as long as broad; clypeus finely punctate over basal one-half, punctures sparse to absent apically with broad shiny impunctate areas; vertex dull, finely and densely punctate. Prothoracic spines long and sharp, about twice as long as width across base; mesoscutum finely and densely punctate, punctures one puncture width apart on anterior and lateral faces, small impunctate area; scutellum finely and densely punctate on posterior and lateral margins, interspaces shiny on median discal area, weak longitudinal median groove; mesepisterna finely and densely punctate, punctures one-half puncture width apart to one puncture width apart below; propodeum with the basal area narrow, quadrately pitted with elongate pits, lateral and posterior faces shiny and weakly roughened, not striate or rugose, latero-posterior margin weakly rounded; tegulae light hyaline brown; wings whitish hyaline with little light apical pubescence, nervures light brown; legs deep brownish black; posterior basitarsi four and three-fourths times as long as broad. Metasomal tergum one with punctures one to two puncture widths apart, most dense on lateral margins;

metasomal tergum two with punctures finer and denser, about one puncture width apart, a deep, sharp basal depression; metasomal tergum three with punctures very fine and dense; metasomal sterna shiny, finely and sparsely folliculated; seventh ventral plates more lobate than other species in the group (fig. 54).

*Female:* length 10 mm., wing length 7.5 mm.

Face with pile most dense about antennal bases and along frontal areas, pile pale grey to white; clypeus with few fine hairs, not concealing surface; vertex with pile tinged with ochreus, and dense; genal areas with upper surface having abundant, long, ochreus pile, becoming much longer, finer, and pure white on lower surfaces, a dense mat of appressed pile posterior to compound eyes; mesoscutum with pile long, dense, and tinged with ochreus; scutellum with pile lighter, longer, and more plumose than on mesoscutum; mesepisterna with long, fine, white pile partially concealing surface, slightly ochreus above; propodeum with dense lateroposterior fringes of long white pile extending down lateroposterior margins to pedicel, lateral faces having a few, short, white appressed hairs, posterior face with abundant, long, erect pile; legs with pile white to light ochreus, long and plumose on posterior femora and tibiae; metasomal terga one to five with very broad, dense apical fasciae of pure white pile; metasomal tergum one with surface almost completely concealed with long, dense, appressed pile, faintly tinged with ochreus, anterior face with many erect white hairs; metasomal tergum two with very broad basal fascia of purse white pile, slightly broader than apical fascia, leaving only narrow nonpubescent rim; metasomal tergum three with basal fascia as broad as apical, leaving weakly pubescent rim between the two fasciae; metasomal tergum four with few, scattered, short, white, appressed hairs forming very weak basal fascia; metasomal tergum six with deep brown to black appressed pile; metasomal sterna nonfasciate with a few light ochreus hairs.

Antennae reddish brown, flagellar segments about as long as broad; malar spaces three-eighths as long as broad; clypeus weakly convex with coarse, striate punctures, most dense about basal portion, becoming larger and more striate apically; vertex shiny with few fine punctures. Prothoracic spines long and sharp, almost twice as long as width across base; mesoscutum densely punctate with punctures less than one-half puncture width apart about anterior and lateral margins; scutellum with punctures dense, almost contiguous on lateral and posterior margins, becoming sparser to-

ward anterior margin which is almost impunctate; mesepisterna deeply punctate with punctures no more than one-half puncture width apart, interspaces shiny; propodeum with the basal area shallowly pitted with elongate, irregular pits, lateral and posterior faces shiny and weakly roughened, not striate or rugose; tegulae light hyaline brown; wings whitish hyaline with short, scattered, brown apical pubescence, nervures light brown; legs deep brownish black; posterior basitarsi four times as long as broad. Metasomal tergum one densely punctate beneath appressed white pubescence, punctures about one puncture width apart, sparser toward anterior face; metasomal tergum two with punctures fine, dense, and no more than one puncture width apart; metasomal terga three to five finely folliculated; metasomal sterna finely and densely folliculated.

*Distribution:* The species abounds in Washington, Oregon, Idaho, Utah, Wyoming, Colorado, North and South Dakota, Nebraska, and Minnesota.

Marginal records include: British Columbia: Osoyoos; Penticton; Okanagan Falls; Fairview. Alberta: Medicine Hat; Scandia; Countess; Wild Horse; Waterton Lakes; Tilley; Orion. Saskatchewan: Swift Current; Eastland; Saskatoon. Manitoba: Lyleton; Hartney. Montana: Marias River; Helena. Iowa: Sioux City. Kansas: Clark County; Hamilton County. New Mexico: Tajique; Las Vegas; Pecos; Carrizozo; Jemez Mountains; Vaughan; Raton. Arizona: Marble Canon; Kayenta; Cedar Ridges. Nevada: Austin. California: Sierraville, Sierra County.

*Flight records:* This species has been recorded from May 21 to September 27 with main flights occurring during July, August, and early September.

*Plant records: Aster, Cleome serrulata, Epilobium spicatum, Grindelia, Gutierrezia, Helenium laciniatum, Malvastrum coccineum, M. cockerelli, Melitotus alba, Petalostemon, Phacelia, Psoralea tenuiflora, Ribes, Senecio douglasii, Solidago, Tetradymia spinosa.*

The holotype of *phaceliae* from Ward, Colorado, is in the collection of the Citrus Experiment Station, Riverside, California, and that of *salicicola geranii* from Boulder, Colorado, is in the United States National Museum.

## GROUP X—*inaequalis*

### *Colletes inaequalis* Say

(Fig. 55)

*Colletes inaequalis* Say, 1837, Boston J. Nat. Hist., vol. 1, p. 391; Leconte, 1859, Writings of the Say Ent., vol. 2, p. 270; Patton, 1879, Proc. Boston Soc. Nat. Hist., vol. 20, p. 142; Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 115; Bridwell, 1899, Trans. Kansas Acad. Sci., vol. 16, p. 210; Cockerell, 1901, J. New York Ent. Soc., vol. 9, p. 132; Smith, 1901, J. New York Ent. Soc., vol. 9, p. 134; Robertson, 1904, Canadian Ent., vol. 36, p. 275; Cockerell, 1905, Psyche, vol. 12, p. 86; Robertson, 1906, Science, vol. 23, p. 309; Britton and Viereck, 1906, Rept. Connecticut Agr. Exper. Sta., pt. 4, p. 210; Lovell, 1907, Canadian Ent., vol. 39, p. 364; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 28; Smith, 1910, Ann. Rept. New Jersey State Mus., for 1909, p. 695; Banks, 1912, Ent. News, vol. 23, p. 107; Cockerell, 1912, Ann. Mag. Nat. Hist., ser. 8, vol. 9, p. 382; Lovell, 1913, Psyche, vol. 20, p. 147; Viereck, 1916, Connecticut Geol. Nat. Hist. Survey Bull., vol. 22, p. 740; Cresson, 1916, Mem. Amer. Ent. Soc., no. 1, p. 108; Sladen, 1919, Canadian Ent., vol. 51, p. 124; Rau, 1922, Trans. Acad. Sci. St. Louis, vol. 24, p. 38; Leonard, 1926, Cornell Agric. Exper. Sta. Mem., no. 101, p. 1021; Robertson, 1926, Psyche, vol. 33, p. 116; 1928, Flowers and Insects, p. 9; Phillips, 1933, J. Agric. Res., vol. 46, p. 860; Rau, 1933, Trans. Acad. Sci. St. Louis, vol. 28, p. 219; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301; Pearson, 1935, Ecological Monogr., vol. 3, p. 384; Brimley, 1938, Insects of North Carolina, p. 451.

*Colletes propinqua* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 165.

*Colletes compactus*, Smith (not Cresson), 1900, J. New York Ent. Soc., vol. 8, p. 208; 1901, J. New York Ent. Soc., vol. 9, p. 30.

*Colletes canadensis* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 166; Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 115; Cresson, 1916, Mem. Amer. Ent. Soc. no. 1, p. 107.

*Colletes inaequalis ferrugineus* Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 32; Smith, 1910, Ann. Rept. New Jersey State Mus., 1909, p. 695 (new synonymy).

The species is closely related to *thoracicus* and at times both sexes are difficult to distinguish from it. The males of *inaequalis* are genitalically distinct from those of *thoracicus* and can usually be distinguished by having a mixture of black pile on the posterior portion of the mesoscutum and on the discal area of the scutellum; the first metasomal tergum of *inaequalis* is always more deeply and densely punctate with punctures one to two puncture widths apart, while the *thoracicus* males have the tergum shiny, sparsely and shallowly punctate. The females of *inaequalis* have a very dense covering of long black pile, especially on the scutellar disc, while in *thoracicus* the scutal and scutellar areas are covered with ferrugineous to deep ferrugineous pile. In many specimens of *thoracicus* from Texas and the southern states the pile of the scutellum is so deeply ferrugineous that it may appear as dark brown or black pile unless examined closely. In the female, as in the male, the first metasomal disc is almost impunctate and the posterior tibiae have a deep longitudinal

sulcus on the dorsal surface running almost the entire length of the tibia; this sulcus is absent in *thoracicus.*

The type and the paratypes of *inaequalis ferrugineus* Swenk have been examined, and I do not consider it to be worthy of subspecific rank. Swenk describes specimens from Willis, Texas, and from Hainsport, New Jersey, as members of the new subspecies and states that he is "inclined to consider it a geographic variant probably restricted to the southern coast portion of the range of the species." Further material from New Jersey, District of Columbia, North Carolina, Georgia, and parts of Texas would indicate that the specimens Swenk used in his descriptions are merely individual variants rather than separate populations. The entire series from Willis, Texas, was caught at the same place and on the same day. That the color of the pile of the body is deep ochreus and distinctive is undeniable, but there is no evidence from other specimens that this is a good subspecific character, for material from Kansas, Ohio, New York, Quebec, North Carolina, and New Jersey shows that the intensity of the color of the pile varies considerably from the pure grey of the typical *inaequalis,* as described from Indiana, to the deep ochreus pile as found in specimens described by Swenk. All of the Swenk material appears to have been newly emerged, for there is very little pile worn from the body. The cause of the color variation eludes me, but in many of the newly emerged "unworn" specimens there is a distinct ferrugineous cast. The northern representatives from Manitoba, Saskatchewan, and westward into the State of Washington show a greater predominance of white pile on the thoracic terga than do more eastern specimens. Other than this there appears to be no evident geographical variation.

*Male:* length 12 mm., wing length 8 mm.

Face with pile long and pure white, evenly distributed about antennal bases, along inner orbital margins, and over clypeus; vertex with pile white; occiput with pile long, white, and plumose, longest about lower occipital regions; mesoscutum with pile white anteriorly, becoming pale grey toward posterior face of mesoscutum, a few, scattered, dark hairs on posterior disc; scutellum with pile pale grey and with mixture of long black hairs about medial discal area and at posterior face; mesepisterna with pile very fine, long, and white; legs with pile fine, sparse, and white; metasomal terga one to five with weak, white apical fasciae, very often interrupted medially due to abrasion; first metasomal tergum with weak lateral fringes, discal area and anterior face with abundant, long, fine, white pile

not concealing surface; metasomal terga two to five with discs having sparse, fine, white pile; metasomal tergum six with pile appressed, white to pale grey; metasomal sterna with weak apical fasciae longest at lateral faces, very short or absent medially.

Antennae long, reddish brown, flagellar segments one and one-half times as long as broad; malar spaces seven-eighths as long as broad; clypeus weakly convex, dull, closely, shallowly punctate giving surface roughened, dull appearance; vertex dull and closely, shallowly punctate. Prothoracic spines absent; mesoscutum closely, shallowly punctate with coarse punctures no more than one-half puncture width apart over anterior and lateral faces; scutellum with punctures deep, weakly striate, and very dense, almost contiguous at posterior margin; mesepisterna dull, shallowly and closely punctate with large punctures; propodeum with basal area irregularly pitted, lateral and posterior faces dull, very finely roughened, not at all striate or rugose; tegulae light brown; wings dusky with abundant, short, brown pubescence, most dense apically, nervures light brown basally, becoming deeper brown apically; legs deep reddish brown on anterior two pairs, posterior pair brown; hind basitarsi very long, four and one-half times as long as broad. Metasomal terga one and two shiny, deeply and densely punctate with punctures approximately one puncture width apart; metasomal terga three to five more shallowly and obscurely punctate with shiny interspaces; metasomal sterna shiny and sparsely folliculated; seventh ventral plates trilobate with median lobe strongest, lobes truncate apically (fig. 55).

*Female:* length 13 mm., wing length 10 mm.

Face with pile long, fine, and erect about antennal bases; vertex with mixture of black and ochreus pile, black pile extending down onto supra-antennal areas and along upper inner orbital margin; mesoscutum with strong mixture of black and ochreus pile; scutellum with abundant, long, black pile over entire discal area with a few, light ochreus hairs most evident about lateral and posterior margins; mesepisterna with the pile pale grey to white below, long and fine but not concealing surface; legs with pile light ochreus on femora and tibiae, occasionally a few, deep ochreus, short, spinelike hairs on basitarsi and tibiae; metasomal terga one to five with weak, pure white apical fasciae, very often absent medially due to wearing; first metasomal tergum with weak lateral fringes of pale grey pile extending to apical fascia, disc and anterior face with abundant, fine, erect, white to pale grey pile not concealing surface; metasomal

terga two to five with discs having few, very short, erect, pale grey hairs, a few longer, deep ochreus hairs appearing on discs four and five; metasomal tergum six with pile appressed, deep ochreus to ferrugineous; metasomal sterna with no apical fasciae, discs with posterior margins having a weak covering of erect, ochreus pile.

Antennae reddish brown, flagellar segments about as long as wide; malar spaces about one-half as long as broad at anterior mandibular articulations, two-thirds as long as broad at posterior mandibular articulations; clypeus bare, deeply striately punctate with shiny interspaces, punctures well separated on lateral margins and much closer on shallowly concave medial area; vertex dull, closely and finely punctate. Prothoracic spines absent; mesoscutum with deep, dense punctures no more than one-half puncture width apart except on posterior medial area where they may be one puncture width apart; scutellum impunctate on extreme anterior margin, becoming deeply striately punctate over posterior two-thirds of disc; mesepisterna dull, obscurely, shallowly punctate; propodeum with basal area narrow, sloping sharply ventrally, shallowly pitted, lateral and posterior faces dull, roughened, not at all striate or rugose; tegulae brown; wings dusky with abundant, short, brownish pubescence especially apically, nervures dark brown; anterior two pairs of legs deep reddish brown, posterior pair brown; posterior basitarsi three and one-half times as long as broad. First metasomal tergum distinctly punctate with punctures approximately one puncture width apart except toward the apical margin where punctures are much finer and closer; metasomal terga two and three densely folliculated; metasomal sterna shiny with hyaline apical margins, discal area coarsely folliculated on sterna two to five.

*Distribution:* The species is the most common member of the genus in America east of the Great Divide and has been recorded from all states and provinces bounded by the following marginal localities: Saskatoon, Saskatchewan; Onah, Manitoba; Spencerville, Ontario; College St. Alexandre, Quebec; Ann County, Nova Scotia; Clayton, Georgia; Marion County, Arkansas; Dallas, Texas; Manhattan, Kansas; Elmore, Idaho, and Cashmere, Washington.

*Flight records:* This is a vernal species, appearing as early as March 5 in the southerly limits of its range and remaining until June 18 in the northern extremities. Swenk reports: "Occasionally individuals of this species emerge in the fall—I have examined two females from Grand Rapids, Michigan, labeled '11-19-1889,' a female from Durham, New Hampshire, taken October 5, 1899, on

*Aster,* and a male taken at Germantown, New Jersey, '11-1-1905' by Mr. H. S. Harbeck. These autumnal specimens are, however, rare, and are to be viewed as abnormally accelerated individuals rather than indicating a fall brood of the species." His conclusion is undoubtedly correct, for of the 750 specimens examined none have been taken later than mid June.

*Plant records:* This polytropic species has been recorded as visiting: *Acer, Aescalus glabra sargentii, Anemone virginiana, Arctostaphalus, Cercis canadensis, Claytonia palustris, Dendrium buxifolium, Dentaria, Lomatium foeniculaceum, Prunus, Pyrus ioensis, Rhamnus utilis, Rhus canadensis, R. aromatica, Ribes, Rubus, Salix, Spiraea vanhouttii, S. thunbergi, Taraxacum, Vibernum acerifolium.*

The type material from Indiana is lost. Unfortunately, there is very little Indiana material in my possession and these few specimens are either damaged or otherwise unsuited for neotype designation. I have chosen a male and a female from Columbus, Ohio, to represent this species as the neotypes. The specimens, while not strict topotypes, are regionally topotypical.

Neotype female: Columbus, Ohio, May 19, 1902 (Bridwell). Neallotype male: Columbus, Ohio, May 3, 1902 (Bridwell).

The neotypes are in the collection of the United States National Museum, the type of *propinqua* is in the Academy of Natural Sciences of Philadelphia, that of *canadensis* from Canada is also in the Academy of Natural Sciences of Philadelphia, and that of *inaequalis ferrugineus* from Willis, Montgomery County, Texas, is in the University of Nebraska collections.

### *Colletes thoracicus* Smith

(Fig. 56)

*Colletes thoracica* Smith, 1853, Cat. Hymen. British Mus., pt. 1, p. 5; Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 171; Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 116; Smith, 1901, J. New York Ent. Soc., vol. 9, p. 134; Cockerell, 1904, Ent. News, vol. 15, p. 276; 1905, Psyche, vol. 12, p. 85; Smith, 1910, Ann. Rept. New Jersey State Mus. for 1909, p. 695; Brimley, 1938, Insects of North Carolina, p. 451.
*Colletes pulcher* Swenk, 1906, Canadian Ent., vol. 38, p. 43 (new synonymy).
*Colletes rufithorax* Swenk, 1906, Canadian Ent., vol. 38, p. 42; Smith, 1910, Ann. Rept. New Jersey State Mus. for 1909, p. 695; Parker and Boving, 1924, Proc. U. S. Nat. Mus., vol. 64, p. 2 ( new synonymy).

The original description is based on specimens taken from New Jersey, North Carolina, and Florida, and agrees closely with *C. rufithorax* Swenk and *C. pulcher* Swenk. Observations made on the types of this species by Dr. Yarrow of the British Museum would tend to substantiate this synonymy. In 1906 Swenk described two

species in the same paper, *C. rufithorax* and *C. pulcher.* I have examined the type of *pulcher* and find it, except for size, identical with a cotype of *rufithorax* taken at the same locality (Fedor, Texas) two days later. Swenk appears to have placed a great deal of weight on the size in both of these species, but I find that this character is extremely variable. Material collected in Washington, D. C., and in North Carolina at what appear to be identical times illustrates over-all length variations from 9.5 to 13 mm. in each locality. The great majority of the specimens from Texas and Louisiana are larger than their eastern counterparts but there is still the same degree of variability in length (10 to 15 mm.). Additional variation exists in the color of the thoracic pile of the males, which may range from grey to light ochreus, irrespective of locality.

The factors influencing the variation exhibited by the lateral portions of the seventh ventral plates of the male are not known. The plate is basically of the *inaequalis* type but has the lateral wings of the trilobate process broadly attached basally. This point of attachment to the main median process fluctuates, so that at times the lateral lobe is a long process overlapping basally and free apically whereas in other specimens from the same locality the lateral process is absent, being united to the median along its entire length, leaving an apex of only two processes. For the present I shall attribute this to a simple genetic factor. The fasciae of the metasomal terga are absent in the female or may be evident as traces of tawny to light ochreus pile on the lateral portions of each segment. In the male the fasciae are usually present, weak but broad; however, in many specimens they have apparently been removed by rubbing and are evident only laterally or not at all.

*Male:* length 12 mm., wing length 9 mm.

Pile of face long, moderately dense over clypeus and antennal bases, pile pale grey to tinged with light ochreus above; vertex with pile long and tinged with ochreus, concentrated principally in ocellar triangle; genal areas with upper surface having abundant short pile, pile pale grey, becoming much more erect, longer, and whiter below; mesoscutum with pile long, dense, and light ochreus over entire surface; scutellum with pile longest and most dense about lateral and posterior margins, pile becoming sparser and shorter on discal area; mesepisterna with pile long, fine, and pale grey; propodeum with dense fringes of long, dusky to tinged with light ochreus pile on lateroposterior margins, being most dense on upper

surfaces, lateral and posterior faces with a sparse covering of erect, pale grey pile; pile of legs long, very sparse, and pale grey, a few darker hairs, principally ochreus, on tibiae; first metasomal tergum with the apical fascia broadly interrupted, evident only as a weak lateral portion, pubescence pale grey, lateral fringes of pale grey pile weak, extending to apical fascia, disc with abundant, erect, pale grey pile; metasomal terga two to five with fasciae very weak and white, fasciae broadly interrupted on second metasomal tergum and just barely present on median portion of terga three and four; metasomal terga three to six having abundant, very short, black pile; metasomal sterna two to four with narrow fringes of pale grey pile, pile longest laterally.

Antennae long, deep brown to black, flagellar segments one and one-half times as long as broad; malar spaces five-eighths as long as broad; clypeus densely punctate with shallow punctures, punctures rather obscure with linear interspaces; vertex densely punctate, dull. Prothoracic spines absent; mesoscutum densely punctate over anterior and lateral surfaces, punctures one-half to one puncture width apart, interspaces shiny, impunctate area virtually absent; scutellum very densely and finely punctate over posterior three-fourths of surface, punctures one-half puncture width apart to contiguous on lateral and posterior margins, becoming one to one and one-half puncture widths apart on disc, extreme anterior face shiny, impunctate; mesepisterna dull, very shallowly, obscurely, longitudinally striately punctate, interspaces dull; propodeum with basal area with deep quadrate pits, lateral and posterior faces dull and rugose, posterior face particularly laterally rugose on median area; tegulae brownish hyaline, finely and rather densely punctate; wings very dusky with abundant, deep fuscous pile over entire surface, nervures dark brown; legs black; posterior basitarsi five times as long as broad. First metasomal tergum finely punctate over entire surface, punctures approximately two to four puncture widths apart laterally, becoming sparser, finer, and shallower on median and anterior faces, punctures most dense on lateral and apical portions; metasomal tergum two with disc uniformly, finely punctate, punctures approximately two puncture widths apart; metasomal sterna shiny, finely and sparsely folliculated; seventh ventral plates with apical portions trilobate, lateral portions broadly joined at base with apical one half free (fig. 56).

*Female:* length 14 mm., wing length 11 mm.

Pile of face erect and dense, particularly about antennal bases

and along inner orbital margins, strongly tinged with ochreus, especially above; clypeus with a few overhanging hairs, not at all concealing surface; vertex with pile ochreus, concentrated principally in ocellar triangle; upper genal areas with pile tinged with light ochreus, pile becoming much finer and lighter below; mesoscutum densely covered with abundant, erect, ochreus pile over entire surface; scutellum with a very broad, dense band of deep ochreus pile about lateral and posterior margins; mesepisterna with pile long, fine, pale grey to white; propodeum with long fringes of dense, pale grey to light ochreus pile along lateroposterior margins, pile most dense on upper surfaces, lateral and posterior faces with a very sparse covering of erect, pale grey to light ochreus pile; pile of legs long and rather sparse except on posterior tibiae and femora, pile predominantly pale grey to ochreus, however with a very strong admixture of shorter, black pile, particularly on tibiae and basitarsi of all three pairs of legs, proportion of black pile becoming much stronger on posterior legs; first metasomal tergum with a very weak fringe of pubescence on extreme apicolateral margins, lateral fringes of pile weak, tinged with light ochreus, and barely reaching apical fascia, disc with a sparse covering of short, erect, pale grey pile; metasomal terga four and five with discs having a sparse covering of long, erect, black hairs, hairs becoming light laterally; metasomal sterna with very fine, weak fringes of pale grey pile on apices of segments two to four, discal areas of these terga with a few erect hairs, not at all scopa-like.

Antennae deep brown to black, flagellar segments one and one-eighth times as long as broad; malar spaces one-half as long as broad, slightly broader toward posterior mandibular articulation; clypeus convex, densely and shallowly striately punctate, interspaces dull; vertex finely and densely punctate, interspaces shiny; fascial foveae greatly broadened above, dorsal edges strongly depressed and rounded, extending three fourths of way from inner orbital margins to lateral ocelli. Prothoracic spines vestigial; mesoscutum very densely punctate, punctures almost contiguous on anterior one half and lateral margins, impunctate area virtually absent; scutellum densely punctate over posterior three fourths, punctures becoming coarser with linear shiny interspaces on median discal area, anterior one quarter shiny, impunctate; mesepisterna dull, densely and shallowly punctate with interspaces dull and roughened, punctures becoming exceedingly obscure below; propodeum with basal area deeply, quadrately pitted, lateral and posterior faces irregularly rugose; tegulae brownish hyaline, finely and rather

densely punctate; wings dusky with abundant, deep fuscous pubescence, nervures brown to dark brown; legs black; posterior basitarsi 3.6 times as long as broad, basitarsi with upper face longitudinally excavated, posterior tibiae with upper posterior faces having a very shallow, longitudinal groove. First metasomal tergum shiny, very finely and sparsely punctate, punctures most dense and finest along apical margins, discal area with punctures three to four puncture widths apart; second metasomal tergum shiny, rather densely folliculated with broad, shiny interspaces; metasomal sterna shiny, coarsely and densely folliculated.

*Distribution:* Massachusetts: Woodshole. New York: Van Courtland Park; Long Island. New Jersey: Avalon; Rahaway; Clementon; Westville; Elmer; Bridgeton; Cresskill; Ft. Dix; Anglesea; Ocean City. Maryland: Plummers Island; Bethesda; Baltimore. District of Columbia: Washington. Virginia: Dismal Swamp; Lake Drummond; Falls Church; Chain Bridge. North Carolina: Ivanhoe; Atkinson; Beaufort; Jacksonville; Lake Waccamaw; Black Mountains; Morehead; Washington; Magnolia; Raleigh; New River. South Carolina: Dewees Island; Charleston. Georgia: Atlanta. Florida: Orange County; St. Augustine; Orlando. Alabama: State record only. Louisiana: Brednox. Texas: Fedor; Colorado County; Tombstone; Trinity; Rockdale; Lexington; Willis. Oklahoma: Caney.

*Flight records:* This is a vernal species, having been recorded from March 13 to June 20, occurring in greatest abundance during March, April, and May.

*Plant records: Ilex, Pyrus* (*Aronia*), *Salix, Vaccinium.*

The holotype of *thoracicus* from St. John's Bluff, East Florida, is in the British Museum (Natural History), London, England, that of *pulcher* from Ocean City, New Jersey, is in the University of Nebraska collections, and that of *rufithorax* from Fedor, Texas, is also in the University of Nebraska collections.

### *Colletes validus* Cresson

(Fig. 57)

*Colletes validus* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 165; Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 248 (questionable); Patton, 1879, Proc. Boston Soc. Nat. Hist., vol. 20, p. 142; Cockerell, 1905, Psyche, vol. 12, p. 85; Britton and Viereck, 1906, Rept. Connecticut Agric. Exper. Sta., pt. 4, p. 210; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 34; Smith, 1910, Ann. Rept. New Jersey State Mus. for 1909, p. 695; Viereck, 1916, Connecticut Geol. Nat. Hist. Survey Bull., no. 22, p. 740; Cresson, 1916, Mem. Amer. Ent. Soc., no. 1, p. 109; Leonard, 1926, Cornell Univ. Agric. Exper. Sta. Mem., no. 101, p. 1021; Pearson, 1933, Ecolog. Monogr., vol. 3, p. 384; Brimley, 1942, Suppl. Insects of North Carolina, p. 36.

This is a close relative of *C. inaequalis*, occurring in abundance in the Atlantic seaboard states during spring and early summer. It is readily distinguished by its large size and exceedingly long malar spaces, one and three-fourths times as long as wide in the male and one and one-fourth times as long as wide in the female. Cresson records the species from Dallas County, Texas, and Pearson (1933) lists it as occurring in Illinois. Both of these localities are out of the known range of the species, and I have not yet seen material from west of the Carolinas except that from Michigan. There is some variation in the size of the species, the males ranging from 10.5 to 12.5 mm. and the females from 11.5 to 15 mm.

*Male:* length 12 mm., wing length 10 mm.

Pile of face very long, dense, and dusky over clypeus and antennal basal regions; vertex with pile long and rather dense, a few dark hairs intermixed; genal areas with pile long, tinged with pale grey to light ochreus, pile becoming much longer and finer below, maintaining light yellowish tinge; mesoscutum with abundant, long, erect pile, pile predominantly pale grey to tinged with ochreus but having a rather strong admixture of fine, black pile, particularly on median discal area; scutellum with a dense fringe of light ochreus pile about lateral and posterior margins, discal area having an admixture of light ochreus and black hairs; mesepisterna with pile long, fine, and pale grey; propodeum with long, dense lateral fringes of light ochreus pile, particularly on upper latero-posterior margins, pile of lateral and posterior faces long, fine, and pale grey; pile of legs long, rather dense, and pale grey; first metasomal tergum with apical fascia narrow, broadly interrupted medially, and white to pale grey, lateral fringes of long, pale grey pile reaching to apical fascia, discal area with abundant, long, erect pile tinged with grey; metasomal terga two to five with fasciae narrow, pale grey, and weak; metasomal terga four to six with discs having a sparse covering of long, erect, black pile; metasomal sterna two to five with weak apical fringes of pale grey pile, pile much longer laterally.

Antennae long, deep reddish brown, flagellar segments one and one-half times as long as broad; malar spaces exceedingly long, one and three-fourths times as long as broad, having weak longitudinal striae extending from bases of eyes to the mandibular articulations; clypeus very long, densely punctate over basal three fourths, apex and apico-lateral faces shiny and sparsely, weakly striately punctate; vertex dull, very densely and finely punctate, compound eyes weakly

petiolate. Mesoscutum very densely and coarsely punctate over entire surface, punctures contiguous to one-half puncture width apart on anterio-lateral surfaces, becoming sparser medially; scutellum with lateral and posterior margins densely, closely, contiguously punctate, punctures becoming more distinct on median discal area, surface dull; mesepisterna dull, very shallowly and densely punctate, punctures becoming obscure below; propodeum with basal area very narrow, shallowly, quadrately pitted and abruptly sloping ventrally, lateral and posterior faces dull and roughened; tegulae deep brown; wings very dusky with abundant, deep fulvous pubescence, nervures brown; legs deep brown to black; posterior basitarsi four and one-fourth times as long as broad. First metasomal tergum finely and densely punctate, punctures one-half to one puncture width apart, interspaces shiny; second metasomal tergum rather coarsely and densely folliculated, with shiny interspaces, follicles one to one and a half follicle widths apart; metasomal sterna shiny, finely and sparsely folliculated; seventh ventral plates much as in *thoracicus*, however with trilobate apical portions broadly separated (fig. 57).

*Female:* length 13 mm., wing length 10 mm.

Pile of face dense, erect, and pale grey about antennal bases and along lower inner orbital margins, abundant, erect, black pile intermixed below antennal bases with a few black hairs on basal area of the clypeus; vertex with pile predominantly black; upper genal areas with pile long, fine, and pale grey to tinged with ochreus, a few black hairs intermixed on anterior portion, pile of genal areas becoming longer, finer, and whiter below; mesoscutum with pile predominantly pale grey to fulvous, having abundant black pile on median discal area; scutellum with dense fringes of light ochreus pile about lateral and posterior margins, disc with abundant, coarse, black pile; mesepisterna with pile long, fine, and white; propodeum with dense fringes of long, pale grey pile on lateroposterior margins, most dense on upper portions, lateral and posterior faces with sparse, erect, pale grey pile; first metasomal tergum with apical fascia weak and white, broadly interrupted medially, lateral fringes of long white pile dense, extending to apical fascia, discal area with sparse, erect, fine, pale grey pile; metasomal terga two to four with fasciae broad, weak, and white to grey; metasomal terga three to five with discal area having abundant, erect, black pile; metasomal sterna two to five with a sparse covering of short, fine, pale grey to fulvous pile.

Antennae long, deep brown to black, flagellar segments one and one-eighth times as long as broad; malar spaces very long, approximately one and three-eighths times as long as broad; clypeus long with a very shallow, longitudinal median groove, surface rather densely punctate along clypeofrontal regions and down median longitudinal groove, lateral faces sparsely, weakly striately punctate, broad shiny interspaces, punctures one to three puncture widths apart; vertex dull, very densely and finely punctate; fascial foveae shallow and curved medially from inner orbital margins. Prothoracic spines absent; mesoscutum densely punctate, punctures contiguous on anterior half and lateral faces, impunctate area absent, median discal are rather sparsely covered with coarse punctures; scutellum dull and roughened, very obscurely and shallowly punctate, punctures barely evident on median discal area; mesepisterna dull, roughened, finely, obscurely, and shallowly punctate, punctures not discernible on disc; propodeum with basal area sharply sloping ventrally, shallowly, quadrately pitted, lateral and posterior faces dull and roughened; tegulae deep brownish hyaline, finely punctate; wings dusky with abundant, deep fulvous pubescence, nervures brown to dark brown; legs deep brown to black; posterior basitarsi 3.7 times as long as broad. First metasomal tergum very finely punctate, with shiny interspaces, punctures one and one-half to three puncture widths apart, becoming closer on the apical margins; second metasomal tergum finely and densely folliculated, with very narrow, shiny interspaces; metasomal sterna shiny, sparsely and finely folliculated on apical half of each sternum.

*Distribution:* The species occurs in abundance along the Atlantic seaboard states, having been recorded from New Brunswick, New York, New Hampshire, Michigan, New Jersey, Pennsylvania, Massachusetts, Connecticut, and North Carolina. Marginal localities are: New Brunswick; Crawford County, Michigan; and Raleigh and Ivanhoe, North Carolina.

*Flight records:* It has been taken between March 6 and July 9.

*Plant records: Prunus, Vaccinium, V. corymbosum.* Swenk records the bee as visiting the flowers of *Ribes oxyacanthoides, Ribes rubrum, Leucothoe racemosa,* and *Chamaedaphne calyculata* in the wet woods and swampy lands.

The holotype from Massachusetts is in the Academy of Natural Sciences of Philadelphia.

## GROUP XI—*impunctatus*

### *Colletes impunctatus lacustris* Swenk

(Fig. 58)

*Colletes lacustris* Swenk, 1906, Ent. News, vol. 17, p. 258; 1908, Univ. Nebraska Studies, vol. 8, p. 39; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario for 1919, p. 131.
*Colletes vicinalis* Graenicher, 1911, Bull. Publ. Mus. Milwaukee, vol. 1, p. 228; 1935, Ann. Ent. Soc. Amer., vol. 28, p. 301 (new synonymy).

This species, originally described by Swenk from Michigan, occurs sparingly across the northern boreal zone of America. I believe that the form is conspecific with *Colletes impunctatus* Nylander of the Palearctic region on the basis of the Noskiewicz description and drawings. He states that the species extends from Mongolia to the region of the Alps and is disjunct in Europe at least. Whether this is a result of incomplete collection has not as yet been ascertained. His drawings of the seventh ventral plates of the species are taken from specimens originating in the Alps, northern Europe (presumably eastern Scandinavia) and eastern Siberia and display distinct differences which—"appear to be constant and suggest the splitting of a species into a number of geographical races." He apparently hesitates in doing so on the basis of insufficient material. The seventh ventral plates of the eastern Siberian specimen agree closely with material from the Yukon and the district of Mackenzie except that the apical projection is about one-fifth again as long as the Noskiewicz illustration. His description agrees closely with the Nearctic material. Graenicher's type of *C. vicinalis* taken from Wisconsin is identical with the typical females of *lacustris*.

*Male:* length 8 mm., wing length 6.75 mm.

Pile of face pale grey, long, especially about antennal bases and overhanging basal portion of clypeus, a few darker hairs along lower inner orbital margins and antennal bases; vertex with pile sparse, dusky, with a few black hairs intermixed, particularly in ocellar triangle; upper genal areas with pile short, sparse, and pale grey with a few darker hairs on anterior margins, pile becoming much longer and finer below, dusky; mesoscutum with pile very long, rather sparse, and dusky to tinged with light ochreus, a few darker hairs, not black, intermixed on the median discal area; scutellum with a very sparse covering of long, erect, dusky pile, with a weak admixture of black hair, black pile very long and fine; mesepisterna with pile long, fine, and dusky; legs with pile sparse, long, and pale grey; propodeum with rather dense fringes of dusky to

dark pile on dorsal lateroposterior margins, lateral faces with a few, erect, dusky hairs, posterior face with abundant, erect pile; first metasomal tergum with a very weak apical fascia, evident only on extreme lateral faces as narrow margins of white pile, lateral fringes of dusky pile very weak, not reaching to apical fascia, disc with abundant, erect, fuscous pile; metasomal terga two to five with fasciae narrow, weak, and white to pale grey, often broadly interrupted medially; metasomal terga three to five with discs having abundant, erect, deep fuscous to black pile; metasomal sterna bare.

Antennae long, reddish brown to black above, flagellar segments one and one-fourth times as long as broad; malar spaces as long as broad; clypeus long and convex with a very shallow, longitudinal median sulcus, surface finely and densely punctate, particularly about clypeofrontal margins and over basal two thirds, fine puncturation extending down median longitudinal sulcus to apex, lateroapical surfaces shiny, impunctate; vertex dull, densely and finely punctate. Prothoracic spines very short and sharp; mesoscutum finely punctate, punctures one-half to one puncture width apart on anterior one half and extreme lateral margins, punctures becoming much sparser toward large median impunctate area; scutellum roughened to contiguously punctate on extreme peripheral margins, punctures becoming more distinct and fine on median discal area where they are approximately one puncture width apart, anterior one-third shiny, impunctate; mesepisterna shallowly, obscurely punctate, giving surface a more roughened appearance, punctures almost completely obscure below; propodeum with basal area very narrow and shallowly, obscurely, quadrately pitted, lateral and posterior faces dull and roughened; tegulae deep brown to black; wings dusky with abundant, deep fulvous pubescence over entire surface, nervures brown; legs deep brown; posterior basitarsi four times as long as broad. First metasomal tergum shiny, sparsely and finely punctate with punctures two to four puncture widths apart, becoming much finer and even sparser medially; second metasomal tergum irregularly folliculated with moderately coarse punctures, much smaller than punctures of first metasomal tergum, interspaces shiny, apical fascial depressions lighter brownish hyaline and impunctate; metasomal sterna shiny, rather finely and sparsely punctate, follicles most dense on apical one half of each sternum, metasomal sterna two and three with apical margins sharply emarginate medially; seventh ventral plates with an enlarged basal discal area, medioapical margins extended faintly, apicomedial processes hyaline

nonpubescent except for an apical fringe of a few, short, fuscous hairs (fig. 58).

*Female:* length 9.5 mm., wing length 6.75 mm.

Pile of face rather sparse, erect, and mose dense about antennal bases, becoming more strongly tinged with fulvous below; vertex with pile predominantly black, particularly in ocellar triangle; upper genal areas with pile light fulvous with an admixture of black pile on anterior faces, pile becoming longer, finer, and sparser below; mesoscutum with pile tinged with ochreus to fulvous, particularly on anterior and lateral margins, a strong admixture of black pile on median discal area; scutellum with a narrow peripheral fringe of fulvous pile, disc with abundant, long, erect, black pile; mesepisterna with pile long, fine, and pale grey; propodeum with long fringes of light fulvous pile on dorsal lateroposterior margins, extending down lateroposterior margin toward pedicel, lateral and posterior faces with a few, erect, pale grey hairs; pile of legs long, moderately dense, and tinged with fulvous; first metasomal tergum with apical fascia evident only on extreme lateral margins as very narrow, white bands, broadly interrupted medially; metasomal terga two to five with fasciae broader, weak, and white, often interrupted medially; metasomal terga four and five with abundant, short, black, erect pile on discs; metasomal sterna bare except for a few apical hairs to each sternum.

Antennae long, reddish brown, flagellar segments as long as broad; malar spaces three-fourths as long as broad; clypeus convex and long, shallowly and rather densely punctate on extreme latero-frontal regions and down a median longitudinal line, interspaces shiny, lateral and latero-apical faces shiny, sparsely punctate with very shallow punctures; vertex finely and variably punctate, punctures one to three puncture widths apart, interspaces shiny, fascial foveae not at all distinct, very narrow. Prothoracic spines vestigial; mesoscutum shallowly, densely punctate over anterior and lateral margins, interspaces shiny, impunctate area large; scutellum closely, obscurely punctate over posterior and lateral margins, punctures becoming sparser on median discal area, approximately one-half to one puncture width apart, anterior one third shiny, impunctate, scutellum with a very weak, longitudinal median groove extending to anterior margins; mesepisterna shallowly, finely, obscurely punctate, surface dull above, becoming much more shiny below where punctures are sparser; propodeum with basal area narrow, very shallowly, obscurely, quadrately pitted,

lateral and posterior faces dull and roughened; legs deep reddish brown; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, very finely punctured to folliculated, virtually impunctate over a broad median discal area; second metasomal tergum very finely and sparsely folliculated, shiny; metasomal sterna shiny, sparsely and finely folliculated.

*Distribution:* New Brunswick: Dalhousie. Quebec: Forestville; Hull. Ontario: Ottawa; Toronto; Sudbury; Haileybury. Maine: Capens; Mount Katahdin. New Hampshire: Randolph. Michigan: Baraga County; Douglas Lake; Pine Lake, Marquette County. Wisconsin: Solon Springs; Douglas County. Minnesota: St. Anthony Park. North Dakota: Mott. Alberta: Banff. British Columbia: Summerland; Inverness; Fort Nelson. Northwest Territories: Cameron Bay; Great Bear Lake; Reindeer Depot, Mackenzie Delta. Yukon Territory: Whitehorse.

*Flight records:* The species has been recorded as flying between June 11 and July 24.

*Plant records:* There are no records of flowers visited on the specimens in my possession. However, Swenk records the type series as being collected in the huckleberry barrens and in meadows and marshy tracts, stating that it quite probably visits the huckleberry blossoms.

The holotype of *lacustris* from Baraga County, Michigan, is in the collection of the University of Nebraska and that of *vicinalis* from Wisconsin is in the Public Museum of Milwaukee.

### GROUP XII—*willistoni*

### *Colletes willistoni* Robertson

(Fig. 59)

*Colletes willistoni* Robertson, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 60; 1895, Trans. Amer. Ent. Soc., vol. 22, p. 116; 1904, Canadian Ent., vol. 36, p. 275; Pierce, 1904, Univ. Nebraska Studies, vol. 4, p. 24 (believed to be *latitarsis*); Robertson, 1906, Science, vol. 23, p. 309; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 14; Rau, 1922, Trans. Acad. Sci. St. Louis, vol. 24, p. 37; Criddle *et al.*, 1924, Rept. Ent. Soc. Ontario, p. 99; Criddle *et al.*, 1925, Rept. Ent. Soc. Ontario, p. 103; Robertson, 1926, Psyche, vol. 33, p. 116; 1926, Ecology, vol. 7, p. 378; 1928, Flowers and Insects, p. 10; Pearson, 1933, Ecolog. Monogr., vol. 3, p. 384; Brimley, 1942, Suppl. Insects of North Carolina, p. 36; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 399.

The species is closely related to *brevicornis* but differs from it in not having the sharp preapical grooves nor the raised flangelike margins on the first three metasomal terga. The first and second

metasomal terga are strongly punctate to the apices and apical fasciae are weak. The females of the species are likely to be confused with *latitarsis*, but differ in having the second metasomal tergum punctate to the apex, rather than with the smooth shiny apical margin of *latitarsis*. The second tarsal segment of the hind leg is one and one-half times as long as broad in *willistoni*, whereas in *latitarsis* the second segment is quite short, about as long as broad.

*Male:* length 9 mm., wing length 6 mm.

Face with hair white, clumped about antennal bases and along inner orbital margins, clypeus bare; vertex with pile pale grey; genal areas with white pile becoming longer toward lower faces; mesoscutum with mixture of black and white pile with white predominating on anterior half; scutellum with black and white pile, discal area almost completely covered with black hair, while lateral and posterior margins rimmed with long, plumose, white pile; mesepisterna with long, white, plumose pile, not concealing surface; propodeum with dense dorso-lateral clumps of long white pile; legs with pile short and pure white; metasomal terga one to five with white fasciae weakest on first and second; first metasomal tergum with dense lateral fringes of long white pile extending to apical fascia, discal area with a few, long, white, erect hairs, not concealing surface; metasomal terga two to five with discs having abundant, short, black pile; metasomal sterna with apical fasciae of very long, sparse, white pile, directed posteriorly, weakest at mid line.

Antennae reddish brown, flagellar segments seven-eighths as long as broad; malar spaces one-half as long as wide; clypeus flattened, dull, with evidence of few shallow longitudinal punctures; vertex dull, weakly roughened, not distinctly punctate. Prothoracic spines blunt, weakly triangular; mesoscutum coarsely and densely punctate with punctures no more than one-half puncture width apart over entire surface; scutellum coarsely, densely, rugosely punctate over entire surface with punctures contiguous with no shiny interspaces; mesepisterna coarsely and densely punctate, punctures almost contiguous leaving linear interspaces; propodeum with lateral and posterior faces weakly rugose, shiny; tegulae light brown, nervures light brown; wings dusky, with abundant, short, brown pubescence, most dense at apex; legs reddish brown; posterior basitarsi three and one-half times as long as broad. First and second metasomal terga densely punctate with punctures varying from one to two puncture widths apart, punctures most dense on median

apical line, terga punctate to extreme apex; second metasomal tergum broadly depressed basally; metasomal terga three to five with discs folliculated; metasomal sterna having discs shiny with a few, fine, scattered punctures; seventh ventral plates with strong laterobasal protuberances, discs with dense covering of pubescence (fig. 59).

*Female:* length 10.5 mm., wing length 6 mm.

Face with hair sparse, erect, and white about antennal bases and along inner orbital margins, clypeus bare; vertex with pile pale grey to light ochreus; genal areas with pile short, erect, and pure white, slightly longer below; mesoscutum with strong admixture of black and white pile, black predominating on discal regions with white most dense on anterior and lateral faces; scutellum with discal area covered with long black hairs, a shorter finer fringe of white pile evident laterally and posteriorly; mesepisterna with short, white, erect pile; propodeum with dorsolateral margins having dense clumps of long white pile; legs with pile light ochreus, a few dark hairs on upper surface of posterior tibiae; metasomal terga one to four with fasciae broad and pure white; metasomal tergum five with fascia much reduced, evident only as a weak rim; first metasomal tergum with distinct lateral fringes of pure white pile extending to apical fascia, anterior face and anterior half of discal area covered with abundant, short, erect, white pile, not at all concealing surface; metasomal terga two to five with abundant, short, fine, black pile; metasomal tergum six with pile deep ochreus to golden brown; metasomal sterna with dense clump of erect, light ochreus pile on second and third metasomal sterna acting as a weak scopa, fasciae absent except for a row of long white pile.

Antennae reddish brown, flagellar segments five-eighths as long as broad; malar spaces one-third as long as wide; clypeus flattened, very weakly concave medially and dull, with evidence of few longitudinal shallow punctures; vertex shiny with a few, scattered, shallow punctures. Prothoracic spines short, triangular; mesoscutum densely punctate with coarse punctures, punctures almost contiguous on anterior and lateral faces, becoming sparser posteriorly, interspaces shiny; mesoscutum with extreme anterior face sparingly punctate, punctures becoming very deep and dense laterally and posteriorly where they are contiguous; mesepisterna rough and rugosely punctate with deep contiguous punctures on upper face, punctures becoming sparser below; propodeum with lateral and posterior faces dull and weakly roughened; tegulae light brown, nervures dark

brown; wings dusky with abundant, short, dark brown pubescence over entire surface; legs deep brown; posterior basitarsi two and three-fourths times as long as broad. Metasomal terga one and two distinctly punctate with punctures varying from one to two puncture widths apart, punctures most dense and distinct on extreme apical portion of the respective segments, punctures extending to extreme apical margins on terga one and two; metasomal tergum two with broad basal depression; metasomal terga three to five densely folliculated; metasomal sterna with discs finely and densely folliculated, dull.

*Distribution:* The species is broadly distributed over eastern America extending west of the Continental Divide into Utah. Marginal localities include: Raleigh, North Carolina; Bethesda, Maryland; Kentville, Nova Scotia; Pt. Pelee, Ontario; Aweme, Manitoba; Washington, Delta, and Smithfield, Utah; Garden City, Kansas; Fedor and Pittsburg, Texas; Carlinville and Odin, Illinois.

*Flight records:* The species has been recorded as flying between May 9 and September 24 with the peak of the population occurring in late June and July.

*Plant records: Melilotus, Monarda punctata occidentalis, Physalis lanceolata, P. virginiana, Psoralea tenuiflora.*

The holotype from Carlinville, Illinois, and the lectoallotype, here designated, a male, number 14670, also from Carlinville, are in the Illinois Natural History Survey Collections.

### *Colletes brevicornis* Robertson

(Fig. 60)

*Colletes brevicornis* Robertson, 1897, Trans. Acad. Sci. St. Louis, vol. 7, p. 315; 1900, Trans. Acad. Sci. St. Louis, vol. 10, p. 51; 1904, Canadian Ent., vol. 36, p. 275; 1906, Science, vol. 23, p. 309; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 12; Graenicher, 1910, Bull. Pub. Mus. Milwaukee, vol. 1, p. 228; Smith, 1910, Ann. Rept. New Jersey State Mus. for 1909, p. 695; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario, p. 131; Robertson, 1926, Ecology, vol. 7, p. 378; 1926, Psyche, vol. 33, p. 116; 1928, Flowers and Insects, p. 10; Brimley, 1938, Insects of North Carolina, p. 451.

*Colletes opuntiae* Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 312; 1907, Univ. Colorado Studies, vol. 4, p. 240; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 12.

This and *C. willistoni* are closely related species, differing primarily in the presence of a flangelike apical margin on metasomal terga one, two, and three in both sexes of *brevicornis.* The antennae of the male are short with the segments scarcely as long as broad. In the typical series from Illinois, raised apical flanges are present on the first three abdominal segments; the flanges and the deep

preapical grooves are more abrupt in specimens taken from Colorado and over the northern states to the eastern seaboard, but on specimens taken from Louisiana and southern Texas the margins and the grooves, particularly on the third metasomal tergum, are reduced. Accompanying this feature there appears to be a reduction or loss of the groove on the medial portion of the first metasomal tergum but it remains quite evident on the lateral margins. In all specimens examined, the preapical groove on the second metasomal tergum is distinct.

*Male:* length 9.5 to 10 mm., wing length 7 mm.

Face with pile long and pure white, most densely clumped about antennal margins and about upper margins of clypeus; vertex with pile white to pale grey, pile becoming longer and sparser on lower portion of genal areas; mesoscutum with abundant, long, white pile, strongly intermixed with black hairs especially on posterior medial area of mesoscutum; scutellum with strong admixture of black pile about lateral and posterior margins; mesepisterna with pile light, long, and weakly plumose, tending to slightly grey above; propodeum with long fringes of pale grey pile on lateroposterior margins, longest and most dense dorsally, lateral and posterior faces with abundant, erect, pale grey pile; legs with pile white and short; metasomal terga one to three with weak apical fasciae of pure white pubescence most evident on extreme lateral faces; metasomal terga four and five with metasomal fasciae broad and pure white; metasomal terga one to six with discs having sparse, short, white pile, not concealing surface; metasomal sterna two to five with narrow, uniform apical fasciae of pure white pile.

Antennae reddish brown, flagellar segments barely as long as wide, first flagellar segment one and one-fourth times as long as second; malar spaces linear at anterior mandibular articulation to one-fourth as long as wide at posterior mandibular articulation; clypeus weakly convex, densely and deeply punctate with very narrow, shiny interspaces; supra-antennal area shiny with very deep, close punctures, approximately one puncture width apart; vertex with punctures shallower and sparser than face, with shiny interspaces. Prothoracic spines vestigial; mesoscutum shiny, densely and coarsely punctate, punctures approximately one-half puncture width apart on anterior half, becoming sparser on posterior medial area, impunctate area absent; scutellum shiny and sparsely punctate over anterior one third, punctures becoming deeper, denser, and almost contiguous towards posterior margin; mesepisterna coarsely, deeply, and closely punc-

tate, punctures no more than one-half puncture width apart; metapleura with upper surface extended to form weak protuberances as is common to the *americanus* group, however rims do not extend posteriorly directly but curve ventrally, ending well along metapleural propodeal suture; propodeum with basal area sloping sharply ventrally, irregularly, quadrately pitted, lateral and posterior faces weakly rugose; tegulae brown; wings dusky covered with short, brown to light ochreus pubescence especially at apex, nervures light brown; legs black; posterior basitarsi three and one-fourth times as long as broad. Metasomal terga one and two deeply and coarsely punctate with shiny interspaces, punctures one to two puncture widths apart medially, becoming much denser laterally where they are no more than one puncture width apart; metasomal terga one to three with deep pre-apical grooves followed by raised flangelike margins; metasomal terga two and three depressed basally; metasomal sterna with apical margins entire; discs shiny, finely and densely folliculated; seventh ventral plates elongate quadrate, emarginate near bases of lateral margins, dense clumps of pile on basomedial portions of plates, apices membranous hyaline (fig. 60).

*Female:* length 10 mm., wing length 7 mm.

Face with white pile of variable length about antennal bases and along inner orbital margins, pile sparse and not concealing surface; clypeus with sparse covering of semierect, white pile, not concealing surface; vertex with pile tinged with ochreus; genal areas with pile white, becoming longer on lower faces; mesoscutum with mixture of short, white and black pile; scutellum with strong covering of black pile, particularly about lateral and posterior margins, a very weak, laterally directed fringe of white pile on extreme lateral margins; mesepisterna with sparse covering of long, fine, white pile; propodeum with weak lateroposterior fringes of white pile extending down toward pedicel, posterior face with short, sparse, pale grey pile; anterior two pairs of legs with pile short and white, posterior femora and tibiae with pile tinged with ochreus; metasomal terga one and two with weak, white apical fasciae, at times only observable on extreme lateral margins; metasomal terga three to five with a broad, dense apical fascia of pure white pile; metasomal terga one to five with discs having short, sparse, white pubescence, not concealing surface; metasomal tergum six with semiappressed, golden to pale grey pile; metasomal sterna two to five with median circular patch of scopalike, ochreus pile; apical margins of metasomal sternum five with a fringe of ochreus pile.

Antennae reddish brown, flagellar segments short, about five-eighths as long as broad, basal flagellar segment one and three-fourths times as long as second; malar spaces linear; clypeus strongly convex, deeply and closely punctate with very narrow interspaces; supra-antennal area deeply and coarsely punctate, becoming shallower and sparser at vertex, interspaces shiny; vertex coarsely punctate with shiny interspaces; fascial foveae deep, broadened slightly median, extending slightly above inner orbital margins, dorsal margins extending three eighths of the distance to lateral ocelli. Prothoracic spines vestigial or triangular; mesoscutum closely, coarsely, and densely punctate over entire surface with punctures no more than one-half puncture width apart; scutellum with anterior margin shiny, impunctate, punctures coarses and denser towards posterior margin where they are almost contiguous; mesepisterna shallowly but densely punctate with punctures no more than one-half puncture width apart; metapleura with upper portion having protuberances similar to those of *americanus* group, but with posterior part of rims extending ventrally down the metapleural-propodeal suture; propodeum with basal area sloping sharply ventrally, shallowly, quadrately pitted, lateral and posterior faces dull, roughened; tegulae deep brown; wings with abundant, short, brown pubescence at apex, becoming sparse to unobservable basally, nervures brown; legs black, tarsi brown; hind basitarsi 3.2 times as long as broad. Metasomal terga one and two coarsely and densely punctate with punctures not more than one puncture width apart and usually much less; metasomal terga one and two with distinct preapical groove followed by raised flangelike apical margins; metasomal tergum three with broader, weakly depressed preapical groove and having flangelike margin raised but slightly; metasomal terga four and five uniform; metasomal sterna dull, and finely and densely folliculated over the apical three fourths; apical metasomal sternum with apical half depressed and almost hyaline with basal arcuate band of overhanging pile.

*Distribution:* The species originally described by Robertson from Carlinville, Illinois, occurs over most of the area east of the Rocky Mountains but nowhere in abundance.

Wisconsin: Two Rivers; Walworth County; St. Croix County; Cranmoor. Michigan: Midland County. Indiana: Elkart; Vincennes. New Jersey: Woodbury. West Virginia: North River Mills. North Carolina: Bryson City; Hookers Island; Raleigh; Kingsboro. Georgia: Wadley; Atlanta. Tennessee: Great Smokies

National Monument. Louisiana: (only a State record). Arkansas: Boles. Texas: 9 miles south Lexington; Sweet Home; Calvert; Dallas; Victoria; Gainsville; Fedor; Jackson County. Oklahoma: Vinita; Ardmore. Kansas: Montgomery County. Colorado: Boulder; Poudre River, Mishawauka. Nebraska: Warbonnet Canyon; Carns. Wyoming: Yellowstone National Park; Rock River. Montana: Glendive. Minnesota: Warren. Manitoba: Aweme.

*Flight records:* The species flies throughout the spring and early summer, occurring later in the more northerly latitudes and higher altitudes. Records from Texas and Georgia show the species as occurring from March 25 to June, while to the north and along the foothills of the Great Divide it has been taken from May until August 14.

*Plant records: Asclepias, Callirhoe involucrata, C. leiocarpa, Campanula, Melilotus alba, Opuntia.* Robertson reports the species to be an oligotropic visitor of *Specularia perfoliata* in Illinois.

The holotype of *brevicornis* from Carlinville, Illinois, is in the Illinois Natural History Survey Collection, the lectoallotype, here designated, a female, number 21868, also from Carlinville, is in the same Collection; the holotype of *opuntiae* from Boulder, Colorado, is in the United States National Museum.

## Group XIII—*consors*

### *Colletes consors* Cresson

(Fig. 61)

This is the largest and most robust species of the entire group, occurring sparingly across eastern North America and in abundance in the mountains from Colorado across the northern edge of the Great Basin into California. (Map 7.)

The seventh ventral plates of the species are distinctive, being roughly quadrate with the apical margins broadly rounded and the surface almost completely covered with long, laterally sloping pile.

*Male:* length 9 to 11 mm., wing length 6.5 to 7.5 mm.

Pile of face sparse, erect, and white on median antennal area and clypeus; vertex with pile white to light grey, concentrated principally in ocellar triangle; mesoscutum with pile long, fine, and sparse, light grey or tinged with ochreus, not at all concealing surface; scutellum with pile long, fine, and light grey or dusky, principally about lateral and posterior edges, however with a weak covering extending over median discal area; mesepisterna with pile

very long, fine, and light grey; propodeum with lateroposterior margins having abundant, long, dense, erect, light grey to dusky pile, lateral and posterior faces with pile much sparser and shorter; first metasomal tergum with apical fascia weak and white to light grey, lateral fringes of white to light grey pile strong and extending to apical fascia; metasomal terga one and two with abundant, erect, long, fine, white or light grey pile over discal areas, very slightly obscuring surfaces; metasomal terga two to five with fasciae broad, weak, and white to grey; metasomal terga three to six with discs having abundant, long, erect, black pile.

Antennae deep brown to black, flagellar segments slightly longer than broad; malar spaces one-half as long as broad; clypeus weakly convex, rather densely and finely punctate about frontoclypeal regions and basal one-half of clypeus, punctures becoming slightly sparser, coarser apically, separated by shiny interspaces, lateroapical and apical margins with punctures tending to be somewhat striate with shiny interspaces. Prothoracic spines short and sharp; mesoscutum finely punctate with broad, shiny interspaces, punctures one to two puncture widths apart, impunctate area small; scutellum densely, contiguously punctate about extreme lateral and posterior margins, disc finely and sparsely punctate, punctures about one puncture width apart, a deep median longitudinal sulcus extending to anterior margin; mesepisterna shallowly punctate with shiny interspaces, punctures one-half to one puncture width apart, becoming much finer and sparser on posterior faces; tegulae deep brownish hyaline; wings dusky with abundant, deep fulvous pubescence over entire surface, nervures dark brown; legs deep reddish brown to black; posterior basitarsi three to three and one-fourth times as long as broad. First metasomal tergum very finely punctate with shiny interspaces; sixth metasomal sternum with apical margin convex medially with truncated shoulders laterally; seventh ventral plates roughly quadrate and small, with apical margins broadly rounded, surface almost completely covered with long, laterally sloping pile (fig. 61).

*Female:* length 10-12 mm., wing length 7-7.5 mm.

Pile of face, vertex and genal areas erect, long, and not concealing surface; mesoscutum with pile long, fine, and dense, tinged with light ochreus; scutellum with a broad band of light ochreus pile about lateral and posterior margins; mesepisterna with pile long, fine, and dense; propodeum with pile longest and most dense on upper lateroposterior margins, lateral and posterior faces with a few, erect, light grey hairs; metasomal terga one and two with

apical fasciae present, at times evident only as narrow patches on extreme lateral faces, discs with abundant, erect, light grey to dusky pile; metasomal terga three to six with discs having abundant, long, erect, black pile; metasomal sterna two and three with abundant, erect, fuscous to black pile on discs, forming a weak scopa, pile becoming much sparser on apical metasomal sterna.

Antennae brown to black, flagellar segments short, about seven-eighths as long as broad; malar spaces one-third as long as broad; clypeus weakly convex, coarsely striately punctate with shiny interspaces, punctures one to two puncture widths apart; vertex shiny, sparsely punctate, fascial foveae very broad and deep, extending above inner orbital margins two thirds of the way to lateral ocelli. Prothoracic spines short, roughly triangular; mesoscutum finely and densely punctate about anterior and lateral margins, punctures about one puncture width apart, impunctate area small; scutellum densely and contiguously punctate about extreme lateral and posterior margins, punctures more distinct on median discal area where they are about one puncture width apart, anterior one third shiny, sparsely punctate; mesepisterna finely punctate with shiny interspaces, punctures about one puncture width apart, coarser above and much finer below; propodeum with basal area sharply sloping ventrally, not quadrately pitted but with a few, irregular, longitudinal rugae, lateral and posterior faces dull and roughened, lateroposterior margins broadly rounded; tegulae deep brown hyaline, almost black; wings dusky, very densely covered with deep fulvous pubescence over entire surface, nervures dark brown; legs brown to black; posterior basitarsi broad, 2.6 to 3 times as long as broad. First metasomal tergum shiny, virtually impunctate, finely and sparsely folliculated; metasomal tergum 2 much as first; metasomal sterna dull, very densely and coarsely folliculated, last metasomal sternum with apical one half sharply depressed and light brownish hyaline with a basal arcuate band of overhanging, deep brown to black pile.

The species is divided into three subspecies as indicated below.

### *Colletes consors consors* Cresson

(Fig. 61)

*Colletes consors* Cresson, 1868, Proc. Boston Soc. Nat. Hist., vol. 12, p. 168; 1872, Trans. Amer. Ent. Soc., vol. 4, p. 249 (questionable); Uhler, 1877, Bull. U. S. Geol. Survey Territ., vol. 3, p. 785; Cockerell, 1899, Catálogo de las Abejas México, Secretaría de Fomento, p. 4 (questionable); 1905, Psyche, vol. 12, p. 87; Snow, 1906, Trans. Kansas Acad. Sci., vol. 20, p. 136; Cresson, 1916, Mem. Amer. Ent. Soc., no. 1, p. 107; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 387; 1951, Wasmann J. Biol., vol. 9, p. 184.

*Colletes myroni* Cockerell, 1908, Entomo., vol. 41, p. 293; 1915, Ann. Mag. Nat. Hist., ser. 8, vol. 15, p. 269; 1928, Univ. Colorado Studies, vol. 16, p. 99; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 387.
*Colletes zonatus* Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 59; Cockerell, 1905, Psyche, vol. 12, p. 87; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; Cresson, 1928, Mem. Amer. Ent. Soc., no. 5, p. 66 (new synonymy).

An examination of the type of *zonatus* Viereck has shown it to be identical with *c. consors* Cresson.

This subspecies occurs principally in Colorado, Wyoming, and Idaho. The males are characterized by having the legs without or with little dusky or black pile, the tergal fasciae white and complete on the first five terga, and white pile abundant on the discs of metasomal terga one and two. In the females the mesepisterna and the legs are covered with long, black, dense pile, the fasciae are only distinguishable laterally on the discs of the first two metasomal terga, and the propodeum is predominantly covered with light pile.

*Male:* length 10 mm., wing length 7 mm.

Pile of face, vertex, and genal areas white to light grey; mesepisterna with pile long, fine, and light grey; pile of the propodeum principally light grey (usually) with a few darker hairs, not black, intermixed on upper lateroposterior margins; legs, particularly tibiae and basitarsi, (usually) with weak admixture of black pile, especially on upper surfaces; metasomal sterna two to five with rather dense apical fringes of light grey pile.

Vertex distinctly punctate with shiny interspaces, punctures about one puncture width apart; posterior basitarsi two and three-fourths times as long as broad; first metasomal tergum distinctly punctate with shiny interspaces, punctures approximately one puncture width apart.

*Female:* length 10 mm., wing length 7 mm.

Pile about antennal bases and inner orbital margins black; vertex with pile consisting of an admixture of black and deep ochreus to deep dusky pile, principally in ocellar region; upper genal area with pile predominantly black or dark, pile becoming longer and finer and remaining deep brown to black on lower genal areas; mesepisterna with pile long, fine, and black; propodeum having upper lateroposterior margin with strong admixture of black pile; pile of legs black, long, and dense.

*Distribution:* The subspecies has been recorded as occurring in Texas, Arizona, and Chihuahua. From the material available I must assume the Texas, Arizona, and Chihuahua specimens to be misidentifications, probably for *C. p. paniscus.*

Colorado: Pinecliffe; Wondervu, Boulder County; 3 miles west Boulder; Estes Park; Garland; Poudre River Canyon; Chimney Gulch; Blackhawk. Wyoming: Jenny Lake, Grand Teton National Park; Yellowstone National Park. Idaho: Kendrick; Willow Flats, Franklin County.

*Flight records:* The species has been recorded as flying between May 21 and July 27.

*Plant records: Hydrophyllum fendleri, Penstemon virens, Phacelia leucophylla, Taraxacum.*

The holotype of *consors* from Colorado is in the Academy of Natural Sciences of Philadelphia, that of *zonatus* from Beulah, New Mexico, is also in the Academy of Natural Sciences of Philadelphia, and that of *myroni* from Boulder, Colorado, is in the Citrus Experiment Station, Riverside, California.

### *Colletes consors pascoensis* Cockerell

*Colletes pascoensis* Cockerell, 1899, Proc. Acad. Nat. Sci. Philadelphia, vol. 50, p. 51; Swenk, 1904, Canadian Ent., vol. 36, p. 94.
*Colletes consors pascoensis*, Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 388.

Timberlake questions the validity of the subspecies *pascoensis* because of his belief that a series of *c. consors* from Colorado would reveal the same variability shown among western specimens. I have found extremely little variation in the Colorado-Wyoming range of *c. consors* and believe the subspecies to be valid.

The male of *pascoensis* differs in having abundant black pile behind the compound eyes, and in having legs with slightly more dark pile. In the female differences are more evident. The lateral faces of propodeum have the pile almost completely black, metasomal terga one and two have the discs with the pile predominantly black and with white fasciae only evident laterally on the first metasomal tergum. Both sexes are usually much larger than the typical *consors*. There is a great deal of variation in the pile of the mesoscutum and the scutellum in particular, varying from a dusky grey to a deep ochreus, and in all instances this appears to be a local variable.

*Male:* length 9.5 mm., wing length 6.5 mm.

Pile of inner orbital margins and of scape with more black intermixed than in other subspecies; pile immediately posterior to upper portions of compound eyes predominantly deep brown to black; pile of the legs dark.

Vertex distinctly, coarsely punctate with shiny interspaces, punc-

tures about one puncture width apart; posterior basitarsi approximately three times as long as broad; metasomal sterna without apical fasciae, shiny, and rather densely folliculated.

*Female:* length 11 mm., wing length 7 mm.

Pile of face, vertex, and genal areas black; mesepisterna with pile long, dense, and black; propodeum with lateral faces and lateroposterior fringe of pile predominantly black; legs with pile black; metasomal terga one and two with apical fasciae absent or evident only on extreme lateral margins as a few dusky hairs; erect pile on discal area of metasomal terga two to five deep brown to black.

Posterior basitarsi broad, approximately two and one-half times as long as broad.

*Distribution:* The subspecies ranges from a southern limit in Inyo and Monterey Counties in California northward to Oregon, Washington, into British Columbia and about the northern edge of the Great Basin, occurring sparingly through southern Idaho and northern Utah. Peripheral localities include Inyo County and Hastings Natural History Reservation, Monterey County, in California; Penticton and Summerland in British Columbia; and Greene Canyon, Cache County and Timpanogos Peak in Utah, where gradation with the typical *consors* becomes more apparent.

*Flight records:* The species flies earlier in the southern part of its range (California and Oregon) than elsewhere, having been recorded as early as April 6. The latest record is July 29 (Chinook Pass, Washington).

*Plant records: Phacelia.*

The holotype from the State of Washington is in the United States National Museum.

### *Colletes consors mesocopus* Swenk

*Colletes mesocopus* Swenk, 1907, Canadian Ent., vol. 39, p. 364; Gibson and Criddle, 1920, Rept. Ent. Soc. Ontario, p. 132; Procter, 1938, Biol. Survey Mount Desert Region, part 6, p. 440, part 8, p. 503.

This form was described by Swenk from Waldboro, Maine, and is rather abundant in the Great Lakes area of eastern America. However, several intergrades taken from Minnesota, Wisconsin, Saskatchewan, and Alberta, indicate that this form should rank no more than a valid subspecies of *consors.* Both sexes, while exhibiting some variation in size, approximate specimens of *c. consors* from Colorado. The species appears to cross the northern Great Plains area into the region of the Great Lakes of eastern North America.

On the basis of the present collections it appears that it is extremely rare in the Great Plains and much more abundant both to the east and the west.

The males differ from *consors* in having no black pile on the face; the legs having only sparse intermixture of dark hairs, and in having the mesepisterna more deeply punctate.

In the females there is no black pile on the face or the mesepisterna; the fasciae are present and rather dense on terga one to five; and there is abundant white pile over the discs of metasomal terga one and two.

In a few specimens taken from the Great Plains there is evidence of varying amounts of black or dark pile behind the compound eyes. There seems to be a general reduction in the length of the pile from the west to the east.

*Male:* length 9 mm., wing length 6.5 mm.

Pile of face, mesepisterna, propodeum, and legs all dusky to light grey, not intermixed with black; metasomal terga one to five with fasciae narrow, weak, and white; metasomal sterna two to five with apical fringes of dusky to light grey pile, pile shortest medially.

Clypeus tending to be somewhat more sparsely punctate, particularly on apical and lateroapical margins where punctures may be two to three puncture widths apart; vertex densely and coarsely punctate, rather dull; propodeum with basal area not abruptly sloping ventrally at posterior margin but irregularly and shallowly pitted; mesepisterna very finely punctate, punctures separated by at least one puncture width; first metasomal tergum shiny, impunctate, very sparsely and finely folliculated; metasomal sterna shiny and sparsely folliculated.

*Female:* length 9.5 mm., wing length 6.5 mm.

Pile of face predominantly white with a few darker hairs on lower inner orbital margins and on lower frontoclypeal area; area immediately posterior to compound eyes with a few, erect, dark hairs; mesepisterna, propodeum, and legs with pile all light; legs strongly tinged with light ochreus; metasomal terga one to four (sometimes five) with fasciae broad, weak, and white; metasomal sterna with discs having abundant, erect, light ochreus pile with a few darker hairs intermixed on apical segments.

*Distribution:* Nova Scotia: King's County. New Brunswick: Tabusintac. Quebec: Hemmingford; Kazubazua; Forestville; Montcerf; Aylmer; Hull; Sully. Maine: Waldboro. Massachusetts:

Needham. Michigan: Otsego County; Douglas Lake. Ontario: Port Sidney; Kearney. Minnesota: Itasca; Kittson County. Wisconsin: Door County; Ashland County. Manitoba: Dauphin; Cormorant Lake. Saskatchewan: Christopher Lake; Melfort. Alberta: Waterton. Northwest Territories: Great Slave Lake, Fort Rae.

*Flight records:* The species has been recorded as flying between June 10 and July 26.

*Plant records: Kalmia, Rubus.*

The holotype from Waldboro, Maine, is in the collections of the University of Nebraska.

*Colletes paniscus* Viereck

(Fig. 62)

The species is most likely to be confused with *C. consors* but differs in the much smaller size and the much less quadrate seventh ventral plate. From all other closely related species it differs in having dark pile along the inner orbital margins and upper genal areas.

*Male:* length 8 to 9 mm., wing length 5 to 5.5 mm.

Pile of face long, ragged, and dusky along median clypeal and subantennal areas, a fringe of black pile of variable width along inner orbital margins; vertex with pile weakly or strongly intermixed with black hair; mesoscutum with pile long, ragged, and dusky to light grey; scutellum with pile long and rather dense, particularly about lateral and posterior margins, light grey to grey; mesepisterna with pile long, fine, and light grey; propodeum with dense fringes of long, light grey pile on the upper lateroposterior margins, lateral and posterior faces with a sparse covering of long, light grey pile; metasomal terga one and two with discs having abundant, erect, white pile, not at all obscuring surface.

Antennae short, deep brown to black, flagellar segments as long as broad; malar spaces approximately three-fourths as long as broad; clypeus long, finely and densely punctate about basal one half, punctures becoming sparser, coarser, and striate toward apex, apical surfaces with shiny interspaces; vertex very densely and coarsely punctate, dull. Prothoracic spines vestigial; mesoscutum finely and irregularly punctate, punctures one-half to two puncture widths apart, impunctate area large; scutellum rather densely, contiguously punctate about extreme lateroposterior faces, becoming coarser and separated by shiny interspaces on median discal area,

anterior one third shiny, impunctate, a longitudinal median sulcus extending to anterior margin; mesepisterna with punctures shallow to obscure, interspaces shiny; propodeum with basal area sloping sharply ventrally, basal area with numerous longitudinal rugae, dull, obscurely and irregularly pitted, lateral and posterior faces dull and roughened, lateroposterior margins broadly rounded; tegulae brown to blackish hyaline; wings dusky with abundant, deep fulvous pubescence, nervures brown; legs black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, variably punctate; metasomal sterna shiny, finely and sparsely folliculated; seventh ventral plates roughly quadrate, slightly broader than long, apical margin weakly rounded at lateral and median edges, laterobasal margin weakly pointed or protuberant, dense transverse fringes of pile extending down median portion of each disc, pile sparse on either side of this dense median hair band, black (fig. 62).

*Female:* length 9 to 9.5 mm., wing length 7 to 7.5 mm.

Pile of the body long, fine, and intermixed with black. Antennae deep brown to brownish black; malar spaces three-eighths as long as broad; clypeus long, densely, coarsely, somewhat striately punctate about basal one-third and frontoclypeal margins, punctures rather dense, coarse, and striate along a broad, median longitudinal line reaching to apex, where punctures tend to become much more obscure and much more striate, extreme apex and lateroapical portions with punctures sparse, striate, and with shiny interspaces; vertex with punctures sparse, deep, with shiny interspaces, punctures one to two puncture widths apart. Prothoracic spines short and sharp, approximately as long as width across base; mesoscutum finely and densely punctate on anterior one half and extreme lateral margins, punctures one-half to one puncture width apart with shiny interspaces; scutellum densely, contiguously punctate over extreme lateral and posterior margins, punctures becoming sparser and more distinct on median discal area where they are one-half to one and one-half puncture widths apart, extreme anterior margin shiny, impunctate; mesepisterna shallowly and rather sparsely punctate, punctures one to two puncture widths apart with shiny interspaces; propodeum with basal area sloping rather sharply ventrally, obscurely and indistinctly pitted with shallow pits, basal area with a number of weak, longitudinal rugae; tegulae deep brown hyaline; wings dusky with abundant, deep fulvous pubescence, nervures dark brown; legs black; posterior basitarsi three times as long as broad.

First metasomal tergum shiny, very finely and sparsely folliculated; second metasomal tergum much as first, with follicles just appreciably more dense; metasomal sterna finely roughened, rather densely and finely folliculated, last metasomal sternum with apical one half sharply depressed and brownish hyaline with an arcuate basal band of overhanging brown pile.

This species is divided into three subspecies as follows.

### *Colletes paniscus paniscus* Viereck

(Fig. 62)

*Colletes paniscus* Viereck, 1903, Trans. Amer. Ent. Soc., vol. 39, p. 60; Cockerell, 1905, Psyche, vol. 12, p. 87; 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 425; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; Cresson, 1928, Mem. Amer. Ent. Soc., no. 5, p. 63; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 387.

*Colletes grisescens* Cockerell, 1930, Amer. Mus. Nov., no. 397, p. 4; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 387.

*Colletes oromontis* Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 61; Cockerell, 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 424; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; Clements and Long, 1923, Carnegie Inst. Washington Publ., no. 336, p. 251; Cockerell, 1925, Ann. Mag. Nat. Hist., ser. 9, vol. 16, p. 628; Cresson, 1928, Mem. Amer. Ent. Soc., no. 5, p. 62; Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 99; 1930, Ann. Mag. Nat. Hist., ser. 10, vol. 5, p. 411; 1934, Amer. Mus. Nov., no. 697, p. 1; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 387.

*Colletes pleuralis* Swenk, 1906, Ent. News, vol. 17, p. 259 (new synonymy).

An examination of *C. pleuralis* Swenk has proven it to be identical with the well known *p. paniscus* Viereck.

Both sexes of this subspecies are smaller and less robust than the following two subspecies. The male differs in having the pile of the vertex predominantly light grey or tinged with light yellow; the pile of the genal areas is all long, fine, and light grey to tinged with yellow, a few dark hairs intermixed above; the legs have the pile short, sparse, and light grey with no dark hairs intermixed; the fasciae are narrow and pure white on metasomal terga one to five; the metasomal sterna two to four have very weak fringes of light grey pile; the mesepisterna have the punctures slightly sparser and more obscure than the other two subspecies; the tegulae are deep black; the first metasomal tergum is shiny with a rather roughened surface and is very finely and sparsely folliculated.

The female has abundant, pale grey pile to tinged with yellow immediately about the antennal bases, the remaining portions of the face are covered with black, erect pile; the upper genal area has the pile predominantly tawny grey extending about the posterior portions of the genal area to the lower faces, there is a narrow fringe of erect, black pile immediately posterior to each compound eye; the mesoscutum and the scutellum have the pile long, grey to

tinged with yellow; mesepisterna with the pile long, fine, and grey; propodeum with the latero-posterior fringes of pile exclusively white; legs with the pile dark or black except on the femora, where it is almost exclusively white on the anterior two pairs of legs and intermixed with light grey on the posterior pair; the first metasomal tergum with the apical fascia white and narrow, weakly interrupted medially, the lateral fringes of pile long, fine, and light grey to white, the disc with abundant, erect, grey pile; metasomal terga two to five with the fasciae broad, dense, and white; second metasomal tergum with the disc having abundant, erect, white pile; metasomal sterna two to four with very weak fringes of white to grey pile, the discs with abundant, erect, black pile, forming a very weak scopa on sterna two and three; propodeum with the basal area much more distinct than on the remaining two subspecies, dull.

*Distribution:* The subspecies occurs from the high plateau areas of Arizona and New Mexico northward into Wyoming and Montana. Peripheral localities include: San Francisco Mountains and White Mountains in Arizona; the Las Vegas Mountains and Beulah, New Mexico; throughout the mountainous portions of Colorado; Green River and Grand Teton National Park, Wyoming; and Gallatin County, Montana. (See comments on Texas, Arizona, and Chihuahua records of *consors consors.*) (Map 8.)

*Flight records:* The species has been recorded as flying between June 15 and August 7, being most abundant in late June and July.

*Plant records: Houstonia, Iris missouriensis, Mertensia franciscana.*

Timberlake also records the species as having been collected on the flowers of *Salix.*

The holotype of *paniscus* from Beulah, New Mexico, is at the Academy of Natural Sciences of Philadelphia, that of *oromontis* from Beulah, New Mexico, is in the Academy of Natural Sciences of Philadelphia, that of *grisescens* from Colorado is in the American Museum of Naturay History, and that of *pleuralis* from Gallatin County, Montana, is in the University of Nebraska collections.

### *Colletes paniscus sculleni* Timberlake

*Colletes paniscus sculleni* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 183.

This subspecies resembles *p. mertensiae* very closely, differing in minor features of pile color. It may be that *p. sculleni* is not worthy of a differentiation from the next subspecies but further collections are necessary to substantiate this.

The males differ from *p. paniscus* in having abundant black pile on the vertex, the upper genal areas, and the anterior genal areas; only on the lower genal areas is the pile pale grey to white. The posterior legs have the pile with a strong admixture of black or deep brown except for fringes of light pile on the femora and trochanters. The metasomal terga have no apical fasciae, and the metasomal sterna are likewise nonfasciate. The mesoscutum is closely and rather coarsely punctate over the anterior one-half with the punctures almost contiguous in certain portions. The tegulae are deep brownish hyaline; the first metasomal tergum shiny, roughened, and very finely and sparsely folliculated; the seventh ventral plates as in the typical *paniscus*, however having the laterobasal projection very short. (Timberlake states that the seventh ventral plates of the male are more quadrate and less narrowed at the outer ends than in either *paniscus* or *mertensiae*. This is so when a restricted number of males are examined; however over the range of the subspecies the shape is no more quadrate than either of the other two subspecies. The laterobasal projection, however, is less pointed than in *p. paniscus*, resembling *mertensiae* very closely.)

The female has the pile of the face, the genal areas, and the vertex exclusively black. The mesoscutum has the pile dusky with an admixture of black pile on the median discal area; the scutellum with lateral fringes of dusky pile intermixed with black on the disc; the mesepisterna with the pile deep brown to black, long, fine, and erect; the propodeum with the lateroposterior fringes having a strong admixture of dark pile; the pile of the legs black, long, and dense; metasomal terga nonfasciate, the first tergum with a sparse covering of erect, whitish pile; metasomal terga two to five with the discs having abundant, erect, black pile; metasomal sterna nonfasciate, sterna two and three with abundant, erect, black pile forming a weak scopa; clypeus tending to be more densely, striately punctate, with the punctures shallower and much more striate to the apex.

*Distribution:* Oregon: Aneroid Lake, Blue Mountains, 7500 feet (holotype); Wallowa Lake, Blue Mountains, 6400 feet (allotype); Anthony Lake, 5500 to 7500 feet; North Powder. Washington: Van Trump; Sumnerland, Mt. Rainier; Sunrise Peak, Rainier National Park; Chinook Pass. Idaho: Willow Flats, Franklin County. Utah: White Pine Lake, Logan, 8000 feet; Hanna; Logan Canyon; Mount Carmel, Zion National Park; Bells Canyon, Salt Lake. Wyoming: Yellowstone National Park, Roosevelt Camp. (Map 8.)

*Flight records:* The subspecies has been taken from June 1 to August 7.

*Plant records: Mertensia, M. paniculata.*

The holotype and allotype are at the Citrus Experiment Station, Riverside, California.

Only in two or three specimens taken from Utah does there appear to be any marked intergradation between *paniscus* and *sculleni* in the color of the pile and that occurs only on the mesepisterna. The morphological differences could easily be bridged by intergradation, as Timberlake suggests, and it would appear logical to assume that at some point in the range of the species there occurs an intermediate form.

### *Colletes paniscus mertensiae* Timberlake

*Colletes paniscus mertensiae* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 182.

The male resembles *p. sculleni* very closely, having the pile of the vertex, upper genal areas, and the areas immediately posterior to the compound eyes with the pile long and black. The mesoscutum has abundant, dark to black pile on the disc, the scutellum with a strong admixture of dark pile on the discal area; the legs deep brown to black except for a few grey hairs intermixed on the basal portions of the femora, trochanters, and coxae; the metasomal terga are nonfasciate, terga one and two with abundant, long, erect, whitish to pale grey pile; the sterna nonfasciate; mesepisterna with the punctures much more distinct and closer than on *p. paniscus*, interspaces shiny; first metasomal tergum shiny, closely and finely punctate with punctures one to one and one-half puncture widths apart; second metasomal tergum very densely and finely punctate, punctures almost contiguous on the mid-line.

The females have the pile of the face, vertex, and genal areas black; mesoscutum strongly covered with black and dusky pile, the black predominating on the median discal areas; scutellum with the pile dusky to black; mesepisterna with the pile long, fine, and deep brown to black; the legs with the pile black except in having a few lighter hairs, particularly on the bases of the femora, trochanters, and the coxae; propodeum with abundant black pile intermixed on the latero-posterior margins; metasomal terga nonfasciate, the first tergum with very narrow lateral remnants of white fasciae; metasomal terga two to five with the discs having abundant, erect, black pubescence; metasomal sterna two and three with the discs having abundant, erect, black pile forming a very weak scopa.

*Distribution:* California: Pohona trail near Yosemite Valley, June 26, 1926 (P. H. Timberlake) on flowers of *Mertensia ciliata* var. *stomatechoides* (holotype, allotype, paratypes); Yosemite, 6000 feet, July 5, 1940 (T. B. Mitchell) (paratypes); Dardanelles, July 8, 1948 (H. M., G. D., and J. Townes) (one specimen). (Map 8.)

The holotype and allotype are at the Citrus Experiment Station, Riverside, California.

### *Colletes nitescens* Timberlake

(Fig. 63)

*Colletes nitescens* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 187.

This species lies much closer to *consors* than to *xerophilus* as indicated by Timberlake. The genitalia of the male and the light pile of the first two metasomal terga are most like those of *consors,* while in the females the fascial foveae of the two species are similar. Both sexes are slightly smaller than the typical *consors* but larger than other members of the group. The males may be confused with *nigrifrons* in certain key characters, but have a few dark hairs along the inner orbital margins; otherwise they differ in the close, dense puncturation of the first two metasomal terga, complete fasciae, and in the flagellar segments which are one and one-fourth times as long as broad. The females exhibit weak fasciae on metasomal terga one to five and have a few dark hairs on the inner orbital margins, vertex, upper mesepisterna, scutum, scutellum, and legs. The first metasomal tergum is finely punctate with punctures about three puncture widths apart; the second tergum has the punctures larger and denser than the first.

*Male:* length 9.5 mm., wing length 6.75 mm.

Pile of face long, sparse, and white; a few black hairs along the lower inner orbital margins; vertex with pile white medially and black laterally; upper genal areas with pile predominantly white except for a few shorter black hairs anteriorly, pile becoming much longer, denser, and whiter below; mesoscutum with pile long, sparse, and dusky; scutellum with pile long, dense, and dusky grey; mesepisterna with pile long, fine, and whitish; propodeum with weak dorsal lateroposterior fringes of long, white pile, lateral and posterior faces with sparse, erect, white pile; legs with pile sparse and white; first metasomal tergum with fasciae very narrow and weak, interrupted medially, weak lateral fringes of pile not extending to apical fascia, discal area with abundant, long, fine, erect, white pile; metasomal terga two to six with fasciae weak, narrow, and inter-

rupted or weakest medially; metasomal terga four to six with abundant, long, erect, deep fulvous to black pile on discs, not concealing the surface; metasomal sterna two to four with short fringes of whitish to light grey pile on extreme apical margins.

Antennae brown, flagellar segments one and one-fourth times as long as broad; malar spaces one-third as long as broad; clypeus weakly convex, very finely and densely punctate over basal two thirds and along median longitudinal line, apical and lateroapical margins sparsely punctate, tending to striateness at extreme lateral faces, interspaces shiny; vertex shiny, sparsely punctate. Prothoracic spines short, vestigial; mesoscutum very densely punctate, punctures approximately one-half puncture width apart, impunctate area small; scutellum not uniformly punctate over posterior one-half, punctures one to three puncture widths apart, becoming most dense posteriorly, anterior face impunctate; mesepisterna shallowly punctate, punctures approximately one-half puncture width apart above, becoming much sparser below, punctures approximately two to three puncture widths apart on lower posterior face; propodeum with basal area very narrow and sloping posteriorly, very shallowly pitted, lateral and posterior faces dull and roughened; tegulae black; wings dusky with abundant, short, fulvous pubescence, nervures dark brown; legs black; posterior basitarsi four times as long as broad. Metasomal terga one and two finely punctate with shiny interspaces, punctures one to two puncture widths apart; metasomal tergum three with many fine punctures, slightly closer than those of the second metasomal tergum; metasomal sterna shiny, sparsely folliculated with coarse follicles over posterior one half; seventh ventral plates roughly diamond-shaped with long fringes of pile along median basal surfaces, median and lateral margins weakly reflexed (fig. 63).

*Female:* length 10.5 mm., wing length 6.75 mm.

Pile of face long, erect, and white about antennal bases and supraclypeal area, a few shorter black hairs on lower inner orbital margins; vertex with pile with a few long hairs tinged with ochreus, abundant shorter finer black pile, particularly along lateral faces; upper genal areas with pile long and light grey, with a few shorter black hairs intermixed at anterior face, pile becoming longer and pure white below; mesoscutum with a dense covering of long, erect, light grey pile on anterior one-third and about lateral margins, disc with scattered, fine, black hairs; scutellum with a dense fringe of light grey pile about lateral and posterior margins; mesepisterna

with pile long, fine, and light grey; metapleura with abundant, fine, dark black hair on upper portions; propodeum with long, dense fringes of white pile on upper lateroposterior margins, lateral and posterior faces with sparse, erect, white pubescence; pile of femora long, plumose, white to tinged with yellow; pile of tibiae and basitarsi strongly intermixed with short, black hair; first metasomal tergum with a very weak apical fascia of white pile, fascia interrupted broadly medially, lateral fringes very weak and sparse, not extending to apical fascia, discal area with sparse, long, erect, whitish pile; metasomal terga two to five with fasciae weak and narrow, pure white; metasomal terga three to five with abundant, short, erect, black pile; metasomal sterna with weak apical fringes of white pile, discal area with abundant, erect, short pile, whitish laterally, more ochreus medially, forming a weak scopa.

Antennae brownish black, flagellar segments three-fourths as long as broad; malar spaces one-third as long as broad; clypeus convex, rounded, very densely punctate over entire surface, punctures weakly striate, more so apically; vertex shiny and punctate, punctures one puncture width apart, fascial foveae broad to the dorsal rim, extending almost half way to lateral ocelli. Prothoracic spines vestigial; mesoscutum densely and finely punctate about anterior one third and lateral margins, impunctate area large; scutellum with punctures restricted to posterior one half, anterior one half shiny, impunctate; mesepisterna shiny and shallowly punctate, punctures one to two puncture widths apart; propodeum with basal area narrow and shallowly, quadrately pitted, lateral and posterior faces dull and very finely roughened; tegulae deep brown to black; wings dusky, densely covered with fulvous pubescence, nervures deep brown; legs brownish black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, very finely punctate, punctures two to four puncture widths apart, sparser medially; second metasomal tergum very coarsely folliculated, follicles almost identical in size to punctures of first tergum but much denser; metasomal sterna dull, very densely folliculated over entire surface, last metasomal sternum with apical one-half sharply depressed, shiny.

*Distribution:* California: Wood Lake, Tulare County, taken in rotary trap April 8, April 26 and May 2, 1947 (N. W. Frazier) (holotype, allotype and paratype); Bass Lake, June 6, 1938, 2500 feet (N. F. Hardman) (paratype).

The holotype is in the collection of the Citrus Experiment Station, Riverside, California.

## *Colletes californicus* Provancher

(Fig. 64)

*Colletes californica* Provancher, 1895, Natural. Canadienne, vol. 22, p. 189; Cockerell, 1903, Psyche, vol. 10, p. 74; Viereck, 1903, Proc. Acad. Nat. Sci. Philadelphia, 1902, p. 730; Cockerell, 1905, Bull. So. California Acad. Sci., vol. 4, p. 31; Bray, 1917, Pomona J. Ent. Zool., vol. 9, p. 99; Cockerell, 1938, Ann. Mag. Nat. Hist., ser. 11, vol. 2, p. 151; 1939, Proc. California Acad. Sci., ser. 4, vol. 23, p. 427; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 181.

This is a vernal species restricted to central and southern California. Both sexes show a little variation in the length of the prothoracic spines, but they are always at least as long as the width across the base of the spine, usually much longer. The males can readily be distinguished from all other members of the *consors* group in having black pile along the inner orbital margins and long prothoracic spines. In the females the prothoracic spines are also long, the face is covered with black pile and there is a complete absence of abdominal fasciae.

*Male:* length 8 mm., wing length 6 mm.

Pile of face long and white over median clypeal area and supraclypeal area, abundant black pile along inner orbital margins; vertex with black, erect pile; upper genal areas with pile black, becoming lighter to deep brown laterally and white below; pile of mesoscutum and scutellum long, dense, and white; mesepisterna with pile black; propodeum with long fringes of white pile on extreme upper lateroposterior margins, lateral and posterior faces with abundant, erect, fine, black pile; pile of legs black except on anterior femora, which are fringed with white to light grey pile; metasomal terga with fasciae absent, terga one to six with abundant, long, erect, black pile; metasomal sterna with pile sparse, long, and black.

Antennae deep reddish brown, flagellar segments scarcely longer than broad; malar spaces three-eighths as long as broad; clypeus weakly convex, finely and densely punctate over basal one-half and along median longitudinal line, apicolateral margins finely, striately punctate; vertex shiny, sparsely punctate. Prothoracic spines long and sharp, approximately one and one-half times as long as width across base; mesoscutum finely and densely punctate, punctures no more than one puncture width apart, impunctate area large; scutellum finely and densely punctate over posterior half, punctures becoming much finer and sparser anteriorly, scutellum not striately punctate; mesepisterna shallowly punctate with shiny interspaces, punctures approximately one puncture width apart above, becom-

ing much sparser below; propodeum with basal area very narrow and shallowly, quadrately pitted, pits almost indistinguishable medially, lateral and posterior faces shiny and finely punctate, punctures one to four puncture widths apart; tegulae deep brown; wings dusky with abundant fulvous pubescence, nervures brown; legs black; posterior basitarsi three and one-half times as long as broad. Metasomal terga one, two, and three finely punctate with shiny interspaces, punctures one to two puncture widths apart, terga with lighter brownish apical depressions; metasomal sterna shiny, rather densely folliculated; seventh ventral plates semilunar in shape, rather densely fringed along the apical margins (fig. 64).

*Female:* length 9.5 mm., wing length 7 mm.

Pile of face long, erect, and black, clumped principally about antennal bases and along inner orbital margins; vertex with pile black; upper genal areas with abundant, erect, black pile, pile becoming brownish towards lower faces; mesoscutum with abundant, erect, long, whitish pile on anterior and lateral margins, a few darker hairs on central discal area; scutellum with pile predominantly light grey, a few dark hairs intermixed on disc; mesepisterna with the pile long, fine, deep brown to black; propodeum with long fringes of pile along the lateroposterior margins, upper margins with pile predominantly light, intermixed with black laterally, becoming pure black along lower lateroposterior margins, lateral and posterior faces with abundant, fine, erect, black pile; pile of legs deep brown to black, long and dense; metasomal terga nonfasciate, with abundant, short, erect, black pile over discal areas of terga one to six; metasomal sterna with sparse, scattered, erect, black pile.

Antennae reddish brown, short, flagellar segments approximately five-eighths as long as broad; malar spaces one-third as long as broad; clypeus weakly convex, closely and rather coarsely striately punctate over entire surface, interspaces shiny; vertex shiny and very sparsely and feebly punctate, fascial foveae very broad above and narrowed below, shallowly depressed and impunctate, reaching almost half way to lateral ocelli. Prothoracic spines long and sharp, approximately one and one-half times as long as width across base; mesoscutum finely and densely punctate, punctures approximately one puncture width apart, impunctate area large; scutellum finely and densely punctate about posterior margins, punctures sparser on median discal area and almost absent anteriorly; mesepisterna shallowly and rather densely punctate, punctures much denser above; propodeum with basal area very narrow and shallowly,

quadrately pitted, pits half as long as broad, lateral and posterior faces shiny and very finely roughened; tegulae deep brown; wings dusky with abundant, long, fulvous pubescence, nervures deep brown; legs black to deep brown; posterior basitarsi three times as long as broad. Metasomal terga one and two sparsely and shallowly punctate, punctures two to four puncture widths apart, interspaces shiny, punctures of second metasomal tergum finer than those of first; metasomal sterna dull and rather densely folliculated, apical metasomal sternum with apical two thirds depressed and not covered with pubescence, depression rimmed on the basal margin by long, overlapping, black hairs.

*Distribution:* The species is restricted to the southern and central portion of California; taken at the following localities: Antioch; Bakersfield; Mojave; Lancaster; Palmdale; Los Angeles; mouth of San Antonio Canyon, Los Angeles County; Deep Creek, San Bernardino County; Riverside; Redlands; Banning; Hemet Reservoir, San Jacinto Mountains; Cranston Ranger Station near San Jacinto; Altadena; Little Rock; Gavilan; San Gabriel; Campo, San Diego County.

*Flight records:* The species has been collected from March 30 to May 31.

*Plant records: Baccharis, Cryptantha, Phacelia distans, Phacelia tanacetifolia, Layia platyglossa.*

The holotype from California is in the Quebec Public Museum, Quebec City, Quebec, Canada.

### *Colletes nigrifrons* Titus

(Fig. 65)

*Colletes nigrifrons* Titus, 1900, Canadian Ent., vol. 32, p. 304; Cockerell, 1901, Psyche, vol. 9, p. 283; Viereck, 1903, Trans. Amer. Ent. Soc., vol. 29, p. 59; Cockerell, 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 424; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 291; 1907, Univ. Colorado Studies, vol. 4, p. 239; 1923, Canadian Ent., vol. 55, p. 206; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 387.

*Colletes florissantia* Cockerell, 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 425; Cockerell, 1907, Univ. Colorado Studies, vol. 4, p. 240; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 387.

*Colletes polemonii* Cockerell, 1906, Bull. Amer. Mus. Nat. Hist., vol. 22, p. 425; 1907, Univ. Colorado Studies, vol. 4, p. 240; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 387.

The males of this species are rather distinctive in having no black pile on the head, thorax, or legs, and having metasomal terga one and two usually sharply and sparsely punctate with punctures much denser on two than on one. The seventh ventral plates are semi-

lunar in shape with rather dense rims of hair along the transverse mid-line.

The female has the head, mesepisterna, and legs all completely covered with a rather sparse, black pile; metasomal terga one and two are deeply and densely punctate with punctures one to two puncture widths apart, although somewhat closer on the second metasomal tergum; fasciae are present on metasomal terga one to four or five and usually, but not always, complete, at times interrupted medially. The malar spaces are almost linear.

A series of *nigrifrons* collected at scattered localities from the Yukon to Quebec is composed of 4 males and 5 females, and in none of these specimens can I detect any significant differences from the typical populations from Colorado other than a slight reduction in the amount of dark pile on the body.

*Male:* length 8 mm., wing length 6 mm.

Pile of face long, dense, and white to light grey, completely concealing clypeus and lower antennal bases; vertex with pile sparse, erect, and light grey to tinged with light ochreus; upper genal areas with pile erect and light grey to tinged with light ochreus, pile becoming much longer and whiter below; mesoscutum with abundant, long, erect, dusky pile; scutellum with pile long, fine, and dusky, concentrated principally on the lateral and posterior faces; mesepisterna with abundant, long, fine, dusky to light grey pile; propodeum with long fringes of dusky pile on upper latero-posterior margins, lateral and posterior faces sparsely covered with shorter, erect pile; pile of legs long, sparse, and dusky; first metasomal tergum with apical fascia narrow and white, usually interrupted medially, lateral fringes of light grey pile weak, barely distinguishable, disc with abundant, erect, dusky pile; metasomal terga two to five with fasciae broader, whiter, and more dense, entire; metasomal terga three to six with the discs having a sparse covering of erect, light grey pile intermixed with much shorter, finer, black pile, light pile predominating; metasomal sterna two to four with very weak apical fringes of light grey pile.

Antennae short, deep brown to black, flagellar segments as long as broad; malar spaces short, approximately one-third as long as broad; clypeus convex, very finely and densely punctate about fronto-clypeal margins and over basal two-thirds, punctures not at all striate, with shiny interspaces, apex and latero-apical margins with punctures much coarser and sparser and having broad, shiny interspaces; vertex dull, coarsely and densely punctate, with narrow,

shiny interspaces . Prothoracic spines short and rather blunt, scarcely shorter than width across the base; mesoscutum finely and rather densely punctate, with shiny interspaces, punctures approximately one-half to one puncture width apart, becoming sparser toward the median impunctate area; scutellum very densely, almost contiguously punctate over posterior one third, punctures becoming sparser and more distinct on the median discal area, anterior one fourth shiny, impunctate; mesepisterna rather distinctly punctate with shallow punctures, punctures approximately one puncture width apart with shiny interspaces; propodeum with basal area sloping ventrally, obscurely and shallowly pitted with irregular pits, lateral and posterior faces dull and finely roughened; tegulae deep brown to blackish hyaline; wings dusky with abundant, deep fulvous pubescence, nervures dark brown; legs deep brown to black; posterior basitarsi approximately 3.3 times as long as broad. First metasomal tergum shiny, distinctly punctate, punctures one to three puncture widths apart; second metasomal tergum much more closely punctate with punctures one-half to two puncture widths apart; metasomal sterna shiny, finely and sparsely folliculated, last metasomal sternum convex medially with truncate shoulders laterally; seventh ventral plates semilunar in shape with rather dense fringes of hair along transverse mid-line (fig. 65).

*Female:* length 9 mm., wing length 6.5 mm.

Pile of face, vertex, and genal areas short, erect, and black; mesoscutum with pile predominantly black, intermixed with dusky hairs, particularly on anterior and lateral margins; scutellum with pile predominantly black, with a few, deep dusky hairs, particularly on lateral margins; mesepisterna with pile long, fine, and black; propodeum with fringes of short, black to dusky pile on the upper latero-posterior margins; legs with pile deep brown to black, rather sparse and short on first two pairs, becoming very long, dense, and plumose on the posterior legs; first metasomal tergum with apical fascia white, evident on lateral one third of the segment, broadly interrupted medially, lateral fringes very weak and composed of short, erect, black pile, disc very sparsely covered with short, erect, dark pile; metasomal sterna two to four with fasciae white to light grey, broadly interrupted medially; metasomal terga two to five with discs having abundant, short, erect, black pile; metasomal sterna two and three with discs having abundant, erect, black pile forming a very weak scopa.

Antennae short, deep brown to black, flagellar segments three-

fourths as long as broad; malar spaces one-fourth as long as broad, becoming slightly broader at posterior mandibular articulation; clypeus convex, coarsely and striately punctate over entire surface with shiny interspaces; vertex rather densely and coarsely punctate with shiny interspaces, punctures no more than one puncture width apart. Prothoracic spines about as long as width across the base, sharp; mesoscutum finely and rather densely punctate over anterior one third and lateral margins, punctures one-half to one puncture width apart, impunctate area large; scutellum densely, contiguously punctate about extreme lateral and posterior margins, disc with punctures much sparser and separated by shiny interspaces, a weak median longitudinal groove extending to anterior margin; mesepisterna rather densely punctate with shiny interspaces, punctures no more than one puncture width apart; propodeum with basal area sloping ventrally, shallowly and obscurely pitted with irregular pits, lateral and posterior faces dull and finely roughened; tegulae black; wings dusky with abundant, deep fulvous pubescence, nervures dark brown; legs black; posterior basitarsi approximately 2.8 times as long as broad. First metasomal tergum finely punctate with punctures not uniform in size, punctures ranging from one to three puncture widths apart; second metasomal tergum more densely punctate than first, with punctures one-half to two puncture widths apart; metasomal sterna dull, coarsely and densely folliculated, last metasomal sternum with apical one half sharply depressed with a basal arcuate hair band overhanging apical depressed area, pile black.

Considerable variation exists in the color of the pile of the mesoscutum and scutellum; in the majority of cases the pile of both the mesoscutum and scutellum is strongly intermixed with black, however many specimens have the pile of both the mesoscutum and scutellum with few or no black hairs intermixed, being almost exclusively dusky or tawny grey. Material from California, Utah, as well as those females from northern Canada tend to have the pile exclusively tawny to dusky, occasionally with a few dark hairs on the discs of the scutellum and the mesoscutum.

*Distribution:* Colorado: Florissant; Peaceful Valley; Leadville; Longspeak; Summit Road, Ouray; Pinecliffe; Boulder; Science Lodge, Boulder County; Ward; Gold Hill; Ohio; Creede; Eldora; Wilkerson Pass; Salida; Westlake. New Mexico: Las Vegas. Arizona: Kahibab Forest. Wyoming: Jenny Lake, Grand Teton National Park; mountains near Sheridan; Jackson; Yellowstone Na-

tional Park; Stewart River Station. Utah: Kastle Valley; Castleton; Hanna. California: Base of Mt. Dana; Tuolumme County; Soda Springs, Tuolumme County; Fresno County; Inyo County; Mono County; Mammoth; Mineralking; Tamarack Lake. Alberta: Waterton Lakes; Calgary; Banff; Cowley. Alaska: Skagway. Yukon Territory: Whitehorse. Northwest Territories: Cameron Bay, Great Bear Lake. Quebec: Seven Islands; Thunder River; Great Whale River.

*Flight records:* The species has been recorded as flying between May 10 and August 10, being found in greatest abundance during the months of June and July.

*Plant records: Drymocallis fissa, Linum lewisii, Mertensia sibirica, Oxytropis, Polemonium, Potentilla hippiana, P. fruticosa, P. anserina, P. glandulosa, Ranunculus.*

A female, Pinecliffe, Colorado, July 9, 1949 (R. H. Beamer), and a male, Salida, Colorado, July 4, 1949 (L. D. Beamer), hereby designated neotype and neallotype of *nigrifrons,* are in the Snow Entomological Collections of the University of Kansas, the holotypes of *florissantia* and *polemonii* from Florissant, Colorado, are in the Citrus Experiment Station, Riverside, California.

### *Colletes xerophilus* Timberlake

The males of this species very closely resemble *nigrifrons* and could well fall within the expected subspecific variation of that species were it not for the distinctive differences exhibited by the female. The male differs from *nigrifrons* in having the flagellar segments approximately one and one-fourth times as long as broad, and in having the puncturation of the first metasomal tergum much finer and sparser, almost folliculated.

The females resemble *nigrifrons* in size but are rather distinctive in having the head and the mesepisterna with the pile all light. The metasomal terga are impunctate and shiny and only the legs are covered with black pile. The clypeus is short and rounded with a shallow median depressed longitudinal sulcus.

*Male:* length 7.5 mm., wing length 5.25 mm.

Pile of face long, white, and dense, particularly above antennal bases and over clypeal area; genal areas with pile sparse and pale grey, becoming much longer below; mesoscutum and scutellum with sparse, long, erect, light grey to dusky pile; mesepisterna with abundant, long, erect, pale grey pile, becoming much whiter below; pile of legs short and sparse and pale grey to white; pro-

podeum with pile long and dense, particularly on lateroposterior margins, lateral and posterior faces with a few, sparse, erect, pale grey hairs; first metasomal tergum with abundant, long, erect, pale grey pile on discal area, lateral fringes weak to absent; metasomal terga two to six with abundant, long, erect, grey to dusky pile on discal area; metasomal sterna two to four with weak apical fringes of dusky pile.

Antennae deep brown, flagellar segments about one and one-fourth times as long as broad; malar spaces one-half as long as broad; clypeus long, rather finely and densely punctate over basal half, punctures becoming much sparser and much more striate apically; vertex coarsely punctate with shiny interspaces, punctures one to one and one-half puncture widths apart. Prothoracic spines very short and sharp; mesoscutum finely punctate, punctures one to three puncture widths apart, impunctate area large; scutellum very densely and finely, almost contiguously punctate about lateral and posterior faces, punctures becoming sparser and more distinct on median discal area where they are approximately one puncture width apart, anterior one third shiny, impunctate; mesepisterna finely and shallowly punctate with punctures approximately same size as those of mesoscutum, punctures one to two puncture widths apart, being sparser below; propodeum with basal area sloping sharply ventrally, very shallowly, obscurely, quadrately pitted, propodeum dull and roughened, lateroposterior margins broadly rounded; tegulae brownish hyaline; wings feebly dusky with sparse covering of fulvous pubescence, nervures brown; legs dark brown; posterior basitarsi long and slender, approximately three and three-fourths times as long as broad. Metasomal terga one and two very finely and sparsely punctate, punctures two to four puncture widths apart with broad, shiny interspaces, punctures slightly closer on second tergum; second metasomal tergum with a very shallow basal depression; metasomal sterna shiny, sparsely and finely folliculated; seventh ventral plates closely resembling those of *C. nigrifrons,* however with plate portion semicircular, laterobasal portions weakly projected in the form of a nipplelike projection, plates with denser mediobasal and latero-basal tufts joined by a shorter transverse fringe of pile, apex covered with very fine and sparse pile (fig. 65).

*Female:* length 9 mm., wing length 6.25 mm.

Pile of face about antennal bases long and white to pale grey; mesoscutum with pile pale grey to white on anterior one half and on lateral margins; mesepisterna with pile long, fine, and pale grey;

propodeum with rather dense fringes of grey pile on lateroposterior margins, most dense on upper surfaces, lateral and posterior faces with a very few, erect, pale grey hairs.

Antennae short, deep reddish brown to black, flagellar segments three-fourths as long as broad; malar spaces approximately one-third as long as broad at anterior mandibular articulation, much broadened at the posterior mandibular articulation where it approximates one-half as long as broad; clypeus convex, apical margin emarginate medially and with a trace of a longitudinal median groove separating surface into two weakly convex lateral portions, surface rather densely punctate over basal half, punctures becoming more striate and sparser apically, with shiny interspaces; vertex shiny, rather densely punctate, punctures one-half to one puncture width apart, fascial foveae very narrow, extending along inner orbital margins dorsally just above the inner margin of the compound eye. Prothoracic spines very short and sharp; mesoscutum finely and sparsely punctate, punctures one to two puncture widths apart on anterior one-half and lateral surfaces, becoming much sparser and irregular on median discal area, impunctate area large; scutellum rather densely and finely punctate about extreme lateral and posterior margins, discal area sparsely and finely punctate, punctures just slightly coarser than those of mesoscutum, median discal area shiny, virtually impunctate; mesepisterna finely punctate, punctures approximately one puncture width apart; propodeum with basal area sloping sharply ventrally, very shallowly and obscurely quadrately pitted, lateral and posterior faces dull, very finely roughened; wings feebly dusky with abundant, deep fulvous pubescence, nervures brown; legs deep brown to black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, virtually impunctate, finely and sparsely folliculated; second metasomal tergum much as first with follicles a little closer, second metasomal tergum with a very shallow, obscure basal depression; metasomal sterna densely and coarsely folliculated, dull, last metasomal sternum with apical five eighths sharply depressed with a long basal arcuate fringe of overhanging pile.

The species is divided into three subspecies. These subspecies are known from so few specimens that their status can only be certainly determined when more material becomes available, but since the names are available, the subspecies are recognized here.

### *Colletes xerophilus xerophilus* Timberlake

*Colletes xerophilus* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 184.
*Colletes xerophilus sonoranus* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 186 (Westmoreland, California, paratypes only.)

*Males:* Pile of the head, vertex, and upper genal areas entirely light; thorax with pile entirely white to tinged with pale grey, metasomal terga one to five with very faint apical fasciae of whitish to light grey pubescence, fasciae scarcely discernible; tegulae brownish hyaline; nervures light brown.

*Females:* Few black hairs along inner orbital margins and scattered on clypeal and subantennal areas; vertex with a few intermixed black hairs; genal areas with pile tinged with fuscous, compound eyes darker; mesoscutum and scutellum with pile having a strong admixture of dark brown, principally on discal areas; pile of legs predominantly dark brown on the femora, tibiae, and tarsi, however with a few lighter hairs in femoral fringes; metasomal terga one to five with very weak apical fasciae of white pile, barely evident medially, discernible as white fringes on lateral portions in particular of first three metasomal terga; metasomal sterna one to five with discs having abundant, erect, black and yellowish pile, forming a very weak scopa, last metasomal sternum with apical depression having an arcuate band of long, deep brown to black, overhanging pile; tegulae brownish hyaline; nervures brown.

*Distribution:* California: Westmoreland, Imperial County, March 23, 1930 (P. H. Timberlake) on flowers of *Salix gooddingii* (holotype, allotype and paratypes); Blythe, Riverside County, April 3, 1945 (Linsley and MacSwain) on flowers of *Salix*.

I have provisionally placed the 2 female paratypes classified by Timberlake as *x. sonoranus* from Westmoreland, California, with this subspecies, as indicated in the discussion under *x. sonoranus*.

The holotype is at the Citrus Experiment Station, Riverside, California.

### *Colletes xerophilus sonoranus* Timberlake

*Colletes xerophilus sonoranus* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 186 (not Californian paratypes).

*Male:* Unknown.

*Female:* Differs from *xerophilus* in having a few darker hairs along inner orbital margins; pile of the vertex, genal areas, and thorax entirely light, grey to tinged with light fuscous; legs with pile long, dense, and lightly tinged with ochreus; metasomal terga one to five

with apical fasciae broad, dense, and pure white, occasionally interrupted medially on first metasomal tergum, lateral fringes of long, white pile extending to the apical fascia; metasomal terga one to six with abundant, erect, white pile on discs; metasomal sterna two to five with abundant, erect, light ochreus pile forming a very weak scopa, last metasomal sternum with apical depression having an arcuate band of long, overhanging, dusky to light ochreus pile; tegulae brownish hyaline; nervures light brown.

*Distribution:* New Mexico: Pecos, June 9 (T. D. A. Cockerell) on flowers of *Salix* (holotype and paratype located at the Citrus Experiment Station, Riverside, California).

Timberlake, in describing this subspecies, included two females which were taken at the same place, same time, and on the same flowers as the females and males of *x. xerophilus.* These specimens are here placed with *x. xerophilus.* Accompanying this removal of the Westmoreland specimens to *xerophilus* it is necessary to assume either that the color of the pile of the legs is a character controlled by a simple genetic mechanism and that light and dark-legged specimens are found in the same population, or if the character is not simple, which appears most probable, that *sonoranus* be elevated to specific rank. Unfortunately I do not have any additional material to that examined by Timberlake and am obliged to follow, temporarily at least, the former of the two assumptions.

### *Colletes xerophilus cismontanus* Timberlake

*Colletes cismontanus* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 186-7.

In the original description, Timberlake suggests that "it is reasonable to suppose that *cismontanus* will ultimately prove to be a coastal race of *xerophilus.*" While I have not seen further specimens from southern California, I would not hesitate to list *cismontanus* as a subspecies of *xerophilus.* There is less difference between *xerophilus* and *cismontanus* than exists between the subspecies *xerophilus* and *sonoranus* (New Mexico specimens).

*Male:* Few, darker hairs along inner orbital margins and on vertex, a few dark hairs just posterior to compound eyes; metasomal terga with apical fasciae absent; terga one to five with abundant, long, fine, white to pale grey pile; tegulae deep brown to black; nervures light brown.

*Female:* Abundant black pile along inner orbital margins, and intermixed on clypeus and below antennal bases; vertex with a few, erect, black hairs; upper genal areas with the pile strongly inter-

mixed with black, areas immediately posterior to each compound eye with abundant, long, fine, black pile; mesoscutum and scutellum with a few darker hairs on median discal area; pile of legs black, except for an admixture of lighter pile, particularly on femoral fringes; metasomal terga with discs of three to five with abundant, erect, black pile; metasomal sterna two to four with abundant, erect, black pile forming a weak scopa, last metasomal sternum with apical depression having an arcuate band of long, overhanging, ochreus to black pile; tegulae brownish black; nervures dark brown; propodeum with basal area very shallowly, obscurely pitted.

*Distribution:* California: Hemet, Riverside County, May 10, 1936 (E. G. Linsley) (holotype and allotype).

The holotype is in the collection of the Citrus Experiment Station, Riverside, California.

### *Colletes sphaeralceae* Timberlake

(Fig. 66)

*Colletes sphaeralceae* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 189.

This is a member of the *consors* group most closely resembling *C. c. mesocopus* Swenk. The species is restricted to the extreme southwestern portion of the United States, found both in the lowlands and at altitudes up to 9700 feet. The gentalia of the male are distinctive as illustrated and the seventh ventral plates do not appear to resemble those of other members of the *consors* group. The female has the apical half of the last sternum depressed apically and with a long fringe of light ochreus pile overhanging the apical depression, closely resembling other females of the group. The present work extends the listed range of the species to Lincoln County, Nevada, and one male has been examined from Trout Creek, Utah. The specimen from Utah differs slightly from the typical series in having the pile of the face, mesoscutum, and scutellum longer, pure white, and very dense, concealing the surfaces; it is similar in all other respects.

*Male:* length 7.5 mm., wing length 6 mm.

Face with pile long, erect, sparse, and slightly tinged with grey, not completely concealing clypeal area, most dense about lateral portions of antennal basal area; vertex with few, scattered, fine, white hairs; genal areas weakly covered with fine white pile, becoming much longer and whiter below; mesoscutum with pile fine, sparse, white to pale grey, not at all concealing surface; scutellum with pile long and white, principally about lateral and posterior

faces; mesepisterna sparingly covered with long white pile; propodeum with no dorsolateral clumps of pile, lateral and posterior faces sparsely covered with long, erect, white hairs; legs with pile short, sparse, and white; metasomal terga one to five with dense apical fasciae slightly tinged with pale grey medially, fasciae much broadened at lateral margins; metasomal tergum one with weak lateral fringes of pale grey to white pile, disc and anterior face with sparse, long, pale grey hairs; metasomal terga two to six having discs with abundant, short, black pile; metasomal tergum six with no apical fascia; metasomal tergum seven with pile deep brown to black, and appressed; metasomal sterna with narrow apical bands of short white pile, discs with abundant, short, semiappressed, pale grey pile.

Antennae short, deep brown to black, flagellar segments about as long as wide, usually slightly shorter; malar spaces three-eighths as long as broad; clypeus short, weakly convex, closely and densely striately punctate, punctures finer basally, becoming coarser and sparser toward apex; vertex shiny, sparsely punctate with broad shiny interspaces. Prothoracic spines short, sharp, roughly triangular; mesoscutum finely and densely punctate, punctures one-half to one puncture width apart about anterior and lateral margins, impunctate area large; scutellum densely and finely punctate over posterior three-fourths of surface, not striately or rugosely punctate, shallow longitudinal median groove most evident on anterior half; mesepisterna densely and coarsely punctate, punctures no more than one-half puncture width apart; propodeum with lateral and posterior faces very finely roughened, posterior face with rudiments of sparse, fine, scattered punctures, surface somewhat shiny; tegulae deep brown, nervures deep brown; wings with apical half having abundant, fine, brownish pubescence; legs black, tarsi brown apically; posterior basitarsi three times as long as broad, much broadened apically. Metasomal tergum one finely and densely punctate, surface dull, punctures one to two puncture widths apart, sparser medially where there is an elevated longitudinal impunctate ridge; metasomal terga two to five finely and densely punctate, punctures almost contiguous, surface dull and roughened; metasomal sterna finely and densely punctate or folliculated with shiny interspaces; seventh ventral plates with discs longitudinally quadrate with dense clumps of pubescence about basal portions (fig. 66).

*Female:* length 9 mm., wing length 7 mm.

Face with pile long, white, and sparse about antennal bases and

inner orbital margins, few long white hairs overhanging clypeus from fronto-clypeal suture; vertex with pile white to pale grey, genal areas with upper surface having pile long and white, becoming much longer and finer below; mesoscutum with pile white, sparser posteriorly; scutellum with pile pale grey concentrated principally about lateral and posterior margins, with a few, shorter, stouter hairs on disc; mesepisterna with pile long, sparse, fine, and pure white; propodeum with dorsolateral clumps of long white pile, lateral and posterior faces with few, fine, short hairs; legs with pile short, sparse, and pale grey, posterior femora and tibiae with pile long, curved, plumose, and tinged with ochreus; posterior basitarsi with a few, long, straight hairs extending out from lateral margins; metasomal terga one to five with broad dense apical fasciae of pure white pubescence; metasomal tergum one with weak lateral fringes of pure white pile, disc and anterior face with a few, scattered, long, fine hairs; metasomal terga two to five with abundant, short, deep brown to black, erect pubescence on discs; metasomal tergum six with pile golden to deep brown, and appressed; metasomal sterna having discs with abundant, erect, deep ochreus pile.

Antennae short, brown, flagellar segments about one-half as long as broad; malar spaces about one-fourth as long as broad; broadest at posterior mandibular articulation; clypeus short and weakly convex, densely striately punctate with shiny longitudinal interspaces, punctures finer and denser basally; vertex shiny, sparsely but finely folliculated. Prothoracic spines short and sharp, roughly triangular; mesoscutum with punctures fine and dense over anterior one third, punctures sparser posteriorly, impunctate area large; scutellum with anterior one third shiny, impunctate, punctures becoming finer and denser toward posterior margin, never striate; mesepisterna densely and coarsely punctate with punctures no more than one-half puncture width apart; propodeum with lateral and posterior faces very finely roughened, not striate or rugose, posterior face with a few, sparse, fine punctures, basal area weakly pitted; tegulae light hyaline brown, nervures deep brown; wings dusky with abundant, short, brown pubescence over apical half; legs black except apical tarsal segments which tend to brown; posterior basitarsi three times as long as broad. Metasomal tergum one shiny, very finely punctate or folliculated with follicles two to five puncture widths apart, a longitudinal median impunctate ridge most evident on apical portion of disc; metasomal terga two to four densely folliculated, dull; metasomal sterna dull, weakly roughened, apical margins hyaline,

impunctate; last metasomal sternum having apical half abruptly depressed and hyaline with rim of light ochreus pile overhanging depression from margin.

*Distribution:* California: Piñon Flat, Idyllwild, Ribbonwood, Saunders Meadows, and Hemet Reservoir in the San Jacinto Mountains; Palm Springs; Tauquitz Lodge, Riverside County; Kramer Junction, San Bernardino County; Westgard Pass Plateau, Kearsarge Pass, Olancha, Owens Valley, Independence, Wild Rose Canyon, Panamint Mountains, Lone Pine, and Mazourka Canyon, in Inyo County. Nevada: Montgomery; Oak Springs, Lincoln County; Lovelock; Kyle Canyon, Charleston Mountains. Arizona: Wickenburg; 10 miles east of Holbrook. Utah: Trout Creek.

*Flight records:* The species has been recorded as flying between March 26 and July 7 with the peak of the population appearing from March to May in the lowland desert region and from May to July in the desert mountains.

*Plant records: Sphaeralcea ambigua.*

The holotype is in the collection of the Citrus Experiment Station, Riverside, California.

### *Colletes wickhami* Timberlake

(Fig. 67)

*Colletes wickhami* Timberlake, 1943, Bull. Amer. Mus. Nat. Hist. vol. 81, p. 394; 1951, Wasmann J. Biol., vol. 9, p. 191.

The female of this species is as yet unknown, although I have a number of unassociated females taken with males in Texas and New Mexico. The association of the sexes is still uncertain and further collections will be necessary to substantiate the tentative placement. On the basis of the quadrate dorso-apical expansions of the penis valves as well as the elongate volsellae and short gonostyli, the species, as Timberlake suggests, is a member of the *consors* group. Some variation is found through the range of this uncommon species. The clypeus of the California paratype taken near Whittier is much more striately punctate with weak longitudinal rugae, while the eastern specimens have a smooth non-rugose surface with punctures sparse and coarse with shiny interspaces. The mesopleura of the Whittier specimen are slightly more coarsely and densely punctate above and the metasomal sternal fasciae tend to be incomplete at the mid-line.

The present work extends the known range of the species to Arizona, New Mexico, Texas, and Kansas.

*Male:* length 8 mm., wing length 6 mm.

Pile of face long, dense, and pure white, completely concealing clypeus; vertex and upper genal areas with sparse, short, erect pile, not at all concealing the surface, pile becoming much longer and more plumose below; mesoscutum with pile white and dense, particularly over anterior two thirds; scutellum with dense white peripheral rim of pile; mesepisterna with pile long, weakly plumose, and white; propodeum with weak fringes of pale grey pile on lateroposterior margins, lateral and posterior surfaces sparsely covered with erect, pale grey pile; legs with pile short, sparse, and white; first metasomal tergum with broad apical fascia of white pubescence, tergum with lateral fringes of white pile extending to fascia, discal area sparsely covered with fine white pile; metasomal terga two to five with fasciae broad and white; metasomal terga four to six with discal areas covered with erect, pale grey to deep testaceous pile; metasomal sterna with fasciae as long lateral fringes, broadened slightly medially, median pile shorter and denser.

Antennae reddish brown, flagellar segments one and one-fourth times as long as broad; malar spaces three-fourths as long as broad; clypeus weakly convex, sparsely striately punctate with shiny interspaces, punctures most dense along median longitudinal line, apical and apico-lateral margins sparsely punctate; vertex shiny with a few fine punctures. Prothoracic spines short and sharp, about as long as width across base; mesoscutum densely punctate over anterior one half, impunctate area large; scutellum coarsely and sparsely punctate over posterior one-half, anterior one half shiny impunctate; mesepisterna coarsely punctate with shiny interspaces, punctures slightly larger than those of mesoscutum; propodeum with basal area shallowly quadrately pitted, lateral faces weakly rugose, shiny, posterior face dull and weakly transversed by striae; tegulae brownish; wings whitish hyaline with sparse, light ochreus pubescence, nervures light brown; legs reddish brown to deep brown; posterior basitarsi three and one-half times as long as broad. First metasomal tergum densely punctate, punctures about one puncture width apart laterally to two to three puncture widths medially; second metasomal tergum with punctures of similar size but slightly closer, no more than two puncture widths apart; metasomal fasciae lying in shallow apical depressions; second metasomal tergum with sharp basal depression; metasomal sterna densely and coarsely folliculated over apical one half; seventh ventral plates elongate quadrate with apical two-thirds very weak and hyaline, almost membranous, a clump of pile on basal portion (fig. 67).

*Distribution:* California: near Whittier, October 11, 1928 (paratype), Oro Grande, San Bernardino County, October 28, 1934 (C. D. Michener) on *Chrysothamnus nauseosus;* Colton, May 26-28, 1917. Arizona: Douglas, June 16, 1942 (E. C. Van Dyke). New Mexico: Carrizozo, June 10, 1950 (L. D. Beamer) on *Helenium laciniatum;* Carrizozo, June 10, 1950 (J. G. Rozen). Texas: Cooper's Store, Big Bend Park, April 11, 1949 (Michener, Beamer) on *Phacelia popei;* 36 miles south Sonora, April 10, 1950 (Beamers, Stephen, Michener, Rozen); Menard, May 2, 1926 (F. C. Bishopp). Kansas: Johnson, June 16, 1949 (C. D. Michener) on *Quincula lobata.*

The holotype from Colorado Springs, Colorado, is in the American Museum of Natural History.

### *Colletes chamaesarachae* Cockerell

*Colletes chamaesarachae* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 49; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 19; 1898, Bull. Denison Univ., vol. 11, p. 43; 1898, Bull. Univ. New Mexico, vol. 1, p. 43; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 20.

I have examined only one specimen of *chamaesarachae* and this, a female, determined by Timberlake from Arizona. This female is apparently not typical, for the first tergum is virtually impunctate, except for fine, lateral punctures. An examination of the apical metasomal sternum fails to reveal anything except a depressed marginal rim rather than the broad apical depression characteristic of the females of the *consors* group. Further material is essential to the clarification of the status of this species. As I have not seen the type I am obliged to quote the original description as given by Cockerell in 1897.

*Female:* "Length about 10 mm., black, with short, dull grey pubescence. Head tolerably broad; eyes not bulging at the top; face and cheeks with sparse grey pubescence; sides of vertex sparsely punctured, shining; a broad dull groove in front of the upper part of each eye; labrum with deep median longitudinal furrow; mandibles stout, rounded at tips, a notch near the end; space between mandible and eye very short; flagellum dark brown beneath from the third joint to the end, its second joint shorter than the third and only half as long as the first. Prothoracic spine rather short, but very slender and sharp. Mesothorax with very large close punctures, absent on the disc. Anterior half of scutellum impunctate, posterior half with large punctures. Base of metathorax divided by ridges into quadrate spaces which are longer than broad. Lateral faces

of posterior truncation irregularly and obscurely reticulate, dullish becoming microscopically lineolate or subreticulate. Pleura closely punctured, subcancellate. Thoracic pubescence short and rather sparse, dull yellowish grey, or, one might say, pale greyish ochreous. Tegulae shining piceous, not noticeably punctured. Wings hyaline, nervures piceous, stigma fuscous. Legs with mouse-colored pubescence; tarsi dark; tibial spurs dark brown; hind spur of hind tibia pectinate, with about fifteen teeth. Inner tooth of claw short diverging from the outer. Abdomen rather narrow, subconical, moderately shiny, punctuation of first segment fine but strong and rather close, of the remaining segments minute and obscure. Base of first segment sparsely hairy; hind margins of segments one to four with bands of whitish pubescence; second segment very feebly pubescent at extreme base. Venter with rather abundant fairly long mouse-grey pubescence."

Cockerell also states, "Hair of thorax with some fuscous hairs intermixed on mesothorax and scutellum; spurs piceous; mesothorax with large, shining impunctate space."

The male is unknown.

Type is unique, taken at Santa Fe, New Mexico, and was taken at the flowers of *Chamaesaracha coronopus* on August 2. Swenk also states the species lies very close to *Colletes crawfordi* but remains distinct from this in the opinion of Professor Cockerell. I can hardly agree with Swenk in his designation of *chamaesarachae* as a member of the *latitarsis* group, and have temporarily placed it here until further material becomes available. The single specimen available is a female from Baboquivari Mountains, Arizona, August 5, 1924 (O. C. Poling).

A female of *chamaesarachae*, in the Timberlake collection, bears the label "Santa Fe, August 2 (Ckll. No. 4081)". This is identical with the data recorded for the type in the original description and therefore this specimen is undoubtedly the holotype.

### *Colletes scopiventer* Swenk

*Colletes scopiventer* Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 46 (♀, not ♂); Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 206-7.

The type agrees closely with the specimens taken from Davis Mountains, Texas. The species seems to occur in the lower Sonoran region and two specimens from California are placed with the species. The scopa is very long and dense; the clypeus convex with sparse, coarse punctures; the fascial foveae are very broad and deep,

extending medially to a point equidistant between the antennal bases and the inner orbital margins.

*Female:* length 9 mm., wing length 6.5 mm.

Pile of face rather long, dense, and white, particicularly about antennal bases and along inner orbital margins; vertex with pile tinged with grey with a few, light ochreus hairs; upper genal areas with pile rather short, sparse, and pale grey, pile becoming longer, sparser, and whiter below, a broad band of appressed, white pubescence immediately posterior to upper portion of the compound eye; mesoscutum with anterior and lateral margins having abundant, short, dense pubescence tinged with pale grey, discal area with black pile intermixed, becoming most predominant on median discal area; scutellum with a dense fringe of short, pale grey pile about lateral and posterior margins, some dark pile intermixed mesad to this peripheral rim; propodeum with dense fringes of pale grey pile on upper lateroposterior margins, extending part way to pedicel, lateral face with a small amount of very short, white, semiappressed pubescence, not concealing the surface, posterior face with abundant, long, erect, pale grey pile; pile of anterior two pairs of legs short and white, posterior femora and tibiae with abundant, plumose, long pile tinged with light ochreus; first metasomal tergum with apical fascia broad and pure white, composed of fine, white pubescence, lateral fringes long and dense anteriorly, becoming very short and sparse towards apical fascia, disc with abundant, erect, white pile, particularly on anterior face; metasomal terga two to five with fasciae broad, very weak, and composed of short, white pubescence; metasomal terga three to five with discal area having very short, sparse, fulvous pubescence; metasomal sterna with posterior one half of each disc having abundant, long, erect, pale grey to light ochreus pile, forming a rather dense scopa.

Antennae reddish brown, flagellar segments short, five-eighths as long as broad; malar spaces short, one-eighth as long as broad; clypeus convex and short, coarsely but very sparsely punctate, punctures approximately one to three puncture widths apart, much finer on extreme lateral margins, becoming coarser and tending to be very weakly striate apically; vertex shiny, shallowly and sparsely punctate; fascial foveae deep, broad, extending medially to a point equidistant to distance from antennal bases from inner orbital margin, dorsal end of fascial foveae extending at least three-fourths of the way from inner orbital margins to lateral ocelli. Prothoracic spines short and sharp, at least as long as width across base; mesoscutum

rather coarsely and densely punctate, punctures one-half puncture width apart anteriorly to one puncture width apart medially, impunctate area very small to absent; scutellum coarsely punctate posteriorly, punctures becoming smaller and sparser towards anterior median portion where they tend to be one to two puncture widths apart, punctures not at all striate; mesepisterna deeply and densely punctate, with shiny interspaces, punctures one-half puncture width apart above to one puncture width apart below; propodeum with basal area sloping sharply ventrally, shallowly, quadrately punctate, lateral faces roughened with weak longitudinal rugae, posterior face dull and roughened irregularly; tegulae deep brownish hyaline; wings dusky with abundant, deep fulvous pubescence, particularly apically, nervures brown to dark brown; legs deep brown to black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, impunctate, except for a few, very shallow, sparse follicles, becoming much closer, finer, and more evident laterally; second metasomal tergum dull, very finely and shallowly folliculated, tergum very weakly depressed basally, fasciae lying in weakly depressed apical margins, fascial margins tending to deep brownish hyaline; metasomal sterna dull, very densely and finely folliculated; last metasomal tergum with apical one half sharply depressed, shiny, impunctate, and nonplumose, with basal overhanging hair band.

*Distribution:* The type is a female taken at Fedor in Lee County, Texas, by the Rev. G. Birkmann. Additional specimens, all females, have been recorded from the following localities: Texas: Davis Mountains, July 9, 1942, June 27, 1942, June 28, 1942 (E. C. Van Dyke); Chisos Mountains, Big Bend, July 3, 1942 (E. C. Van Dyke); 36 miles south of Sonora, April 14, 1950 (Michener, Beamers, Rozens, Stephen); 15 miles north of Del Rio, April 11, 1950 (Michener, Beamers, Rozens, Stephen); Van Horne, April 14, 1950 (Michener, Beamer). Arizona: Tombstone, August 13, 1940 (C. D. Michener). California: Riverside, September, 1935 (Reeves); Redlands (F. R. Cole).

*Plant records: Chamaesaracha conioides, Solanum rostratum.*

The holotype is in the collections of the University of Nebraska.

### *Colletes texanus texanus* Cresson

(Fig. 69)

*Colletes texana* Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 249; 1916, Mem. Amer. Ent. Soc., no. 1, p. 109; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 402.

The species was originally described from a female taken in Comal County, Texas. It was supposedly redescribed by Swenk in 1908, but the redescription is apparently based on another species, *swenki,* described elsewhere in this paper. I have not seen the specimens used by Swenk; however, from the description there can be no doubt as to the misidentification for he described the female as having "malar space very short, one-ninth as long as broad. Prothoracic spine reduced to a mere pointed angulation. Clypeus shiny, convex, not sulcate. Abdomen shining, the first segment polished and subimpunctate." In the type the malar spaces are one-third as long as broad; the prothoracic spines long and sharp; the clypeus long, flattened, with a distinct longitudinal median sulcus; and the first metasomal tergum closely and deeply punctate. *Colletes crawfordi* described from Dallas differs but slightly from the more southerly specimens of *texanus;* the first metasomal tergum is more closely and deeply punctate in *crawfordi* and there are fewer dark hairs on the posterior tibiae and basitarsi. *C. crawfordi* undoubtedly ranks only as subspecifically distinct from *texanus.* The species superficially resembles *intermixtus* but is readily distinguished from that by the coarse, close puncturation of the first metasomal tergum.

*Male:* length 7.5 mm., wing length 5.25 mm.

Pile of face most dense, longest, and whitest about antennal bases and along inner orbital margins; the clypeus weakly covered with long, white pile; vertex with pile pale grey and sparse; upper genal areas with upper surfaces having abundant, short, pale grey pubescence, pile becoming much longer and whiter below; mesoscutum with weak admixture of dark to black hairs on discal area, with abundant, short, pale grey pile; scutellum with a rather dense lateral and posterior fringe of pale grey pile, a few darker hairs intermixed; mesepisterna with pile long, sparse, and pale grey; pile of legs short, sparse, and pale grey; first metasomal tergum with apical fascia narrow and composed of short, white pubescence, lateral fringes weak and barely reaching apical fascia, discal area with sparse, erect, long, pale grey pile, not at all concealing the surface; metasomal terga two to five with fasciae broader than that of first tergum,

pubescence white and moderately dense; metasomal terga three to five with discal area having abundant, short, deep, fulvous to black, erect pile, not at all concealing surface; metasomal sterna two to four with apical fringes of fine, white to pale grey pile.

Antennae short, deep brown to black, flagellar segments barely longer than broad; malar spaces about as long as broad; clypeus flattened with a very weak, longitudinal median sulcus, surface sparsely punctate with shiny interspaces, punctures most dense and most striate along median longitudinal line, punctures becoming much sparser on lateroapical margins; vertex shiny, very sparsely and shallowly punctate, fascial foveae deeply depressed and curved at dorsal face to lateral ocelli. Prothoracic spines long and sharp, twice as long as the width across base; mesoscutum coarsely and densely punctate over anterior one half and lateral faces, punctures one puncture width apart, impunctate area small; scutellum densely and coarsely punctate over posterior two thirds, punctures no more than one-half puncture width apart, becoming sparser at anterior and anteromedial faces; mesepisterna densely and rather coarsely punctate, punctures almost contiguous above, becoming sparser below; propodeum with basal area rather deeply, quadrately pitted, lateral and posterior faces roughened and dull, covered with many weak rugae; tegulae black; wings slightly dusky with abundant, deep fulvous pubescence, nervures deep brown; legs black; posterior basitarsi four times as long as broad. First metasomal tergum rather densely and coarsely punctate, punctures one to one and a half puncture widths apart, interspaces shiny; second metasomal tergum with punctures finer, almost folliculated, and closer along anterior and median faces; metasomal sterna dull, rather finely and densely folliculated; seventh ventral plates very short and extended laterally, preapical fringes of long, dense pile extending from the median to lateral faces (fig. 69).

*Female:* length 9 mm., wing length 6 mm.

Pile of face short, white, and concentrated principally along lower inner orbital margins and laterad of antennal bases; vertex with pile sparse and pale grey; upper genal areas with pile short, pale grey, becoming longer, finer, and whiter below, a weak fringe of appressed, pale grey pubescence immediately posterior to each compound eye; mesoscutum with abundant black pile on median discal area intermixed with short, pale grey pile on anterior and lateral faces; scutellum with lateral and posterior faces having abundant, intermixed black and pale grey pile; mesepisterna with

pile long, fine, and white; propodeum with short fringes of white pile on upper lateroposterior margins, lateral and posterior faces with sparse, erect, whitish pile; pile of anterior two pairs of legs white, pile of posterior femora long, plumose, and tinged with pale grey, posterior tibiae with abundant, short, black pile intermixed with grey on upper surfaces; first metasomal tergum with apical fascia weak, narrow, and white, lateral fringes of pile very short, weak, and not quite reaching apical fascia, disc with anterior face having abundant, short, white pile, erect and not concealing surface; metasomal terga two to four with fasciae broad, weak, and white, often interrupted due to removal of pubescence; metasomal terga three to six discal areas having abundant, very short, black to deep fuscous pile, pile not concealing surface; metasomal sterna with discs having abundant, long, erect, white pile, forming a strong scopa.

Antennae brown to brownish black, flagellar segments approximately three-fourths as long as broad; malar spaces three-eighths as long as broad; clypeus flattened, shiny, a very weak longitudinal median sulcus, most evident on central portion of clypeus, punctures sparse, striate, with broad, shiny interspaces, punctures approximately one to three puncture widths apart, apical and lateroapical margins shiny, sparsely punctate; vertex shiny, virtually impunctate, fascial foveae very deep, expanded slightly medially and with dorsal margins curved medially towards lateral ocelli, reaching over half way to lateral ocelli from inner margin of the compound eye. Prothoracic spines very long and sharp, at least twice as long as width across base; mesoscutum very densely and coarsely punctate, impunctate area small, almost absent; scutellum with punctures very coarse over posterior two thirds, tending towards striateness at median line; mesepisterna very coarsely, almost contiguously punctate, dull above and shiny below; propodeum with basal area deeply, quadrately pitted, lateral and posterior faces dull and roughened; tegulae deep brown to black; wings feebly dusky with abundant, deep fulvous pubescence, nervures deep brown; legs dark brown to black; posterior basitarsi three and one-half times as long as broad. First metasomal tergum finely and rather densely punctate, punctures one to two puncture widths apart, being much finer at apical and median lines; second metasomal tergum rather densely and coarsely folliculated; metasomal sterna dull, densely folliculated; last metasomal sternum with apical one fourth depressed, shiny, and impunctate, with a basal fringe of long, overlapping pile.

*Distribution:* Texas: Donna, September 3, 1933 (J. W. Monk); Austin (A. L. Melander); Progresso, April 12, 1950 (Michener, Rozens, Beamers, Stephen); Brownsville, March 26, 1951 (C. D. Michener); San Benito, March 28, 1951 (R. H. Beamer); Southmost, Cameron County, March 27, 1951 (C. D. Michener).

This is the first record of the male of *t. texanus* and the specimen from San Benito, March 28, 1951 (R. H. Beamer) has been designated as the neallotype.

The holotype from Texas is in the Academy of Natural Sciences of Philadelphia; the neallotype is in the Snow Entomological Collections of the Universty of Kansas.

### *Colletes texanus crawfordi* Swenk

*Colletes crawfordi* Swenk, 1906, Ent. News, vol. 17, p. 257; 1908, Univ. Nebraska Studies, vol. 8, p. 20.

This subspecies occurs in the northern and western parts of Texas, having been taken from Dallas west to San Angelo. This is the first record of a male of *texanus crawfordi.*

*Male:* Smaller in size than typical *texanus;* mesoscutum and scutellum almost devoid of black pile; fascial foveae more distinctly depressed and only weakly curved toward lateral ocelli; tegulae light hyaline brown; nervures light brown; first metasomal tergum just appreciably more coarsely and densely punctate.

*Female:* Very similar to *texanus* except in not having black pile on mesoscutum, occasionally a few darker hairs on median discal area; tegulae are brownish hyaline and nervures brown; first metasomal tergum appreciably more densely punctate, punctures very fine as in typical *texanus.*

*Distribution:* Texas: Dallas, October 8, 1905 (A. J. Leister) on *Physalis;* San Angelo, September 27 (J. C. Crawford) on *Physalis;* Plano, July 19 (A. J. Leister); Dallas, July 19 (A. J. Leister) (neallotype).

The holotype and the neallotype from Dallas, Texas, are in the collection of the University of Nebraska.

### *Colletes swenki* sp. nov.

(Fig. 68)

?*Colletes texanus,* Swenk (not Cresson), 1908, Univ. Nebraska Studies, vol. 8, p. 44.

This may be the species referred to by Swenk as *texanus.* The species is doubtfully placed in the *consors* group, for the antennal segments of the male are one and one-fourth times as long as wide

and in the females there is no distinct depression to the last apical sternum; however there is a narrow, depressed rim. The females closely resemble *linsleyi*, which does appear to be a member of the *consors* group. The males have the malar spaces one-fourth as long as wide, short and sharp prothoracic spines, a sparsely punctate first metasomal tergum, and a basally depressed second metasomal tergum. In the females the malar spaces are about one-eighth as long as wide, the clypeus closely and coarsely punctate, and the abdominal scopa dense. The mesoscutum and scutellum have black pile and the fascial foveae are deep and narrow.

*Male:* length 8.5 mm., wing length 6 mm.

Pile of face long and dense, extending well above the antennal bases, pile white; vertex with pile white to pale grey, sparse; upper genal areas with pile pale grey and short, becoming longer and whiter below; mesoscutum with abundant, white to pale grey pile over anterior one-half, discal area with a weak admixture of darker pile; scutellum with a peripheral rim of long, pale grey pile, with abundant black pile mesad to peripheral rim; mesepisterna with pile long, fine, and white; propodeum with long fringes of white pile on upper lateroposterior margins, lateral and posterior faces with sparse, shorter, white pile; pile of legs sparse, short, and white; first metasomal tergum with a long, dense, white apical fascia, lateral fringes long, white, and dense extending to fascia, discal area with pile long, white, and erect; metasomal terga two to five with fasciae broad and rather weak, each apical margin of tergum protruding beyond limits of the fascia, fascia white; metasomal terga three to six with abundant, pale grey to whitish, erect pubescence on discs; metasomal sterna two to four with weak fringes of long, pale grey pile on apical margins.

Antennae deep brown to black, flagellar segments one and one-fourth times as long as broad; malar spaces one-fourth as long as wide; clypeus convex and short, very densely and closely punctate, punctures not contiguous and very weakly striate apically; vertex shiny, sparsely punctate. Prothoracic spines very short and sharp, almost vestigial; mesoscutum very densely and coarsely punctate over anterior one-half and lateral margins, impunctate area small; scutellum rather coarsely punctate, punctures of variable denseness, varying from one-half to one puncture width apart on median discal area, punctures much finer, virtually absent on anterior faces, punctures not at all striate; mesepisterna very densely, contiguously punctate with linear interspaces; propodeum with basal area sloping sharply ventrally, very shallowly, longitudinally, quadrately

pitted, lateral and posterior faces roughened and dull; tegulae deep brown; wings dusky with abundant, fulvous pubescence, particularly apically, nervures dark brown; legs deep brown to black; posterior basitarsi four times as long as broad. First metasomal tergum shiny, very finely, shallowly, and sparsely punctate, punctures almost follicle-like and three to five puncture widths apart; second metasomal tergum very finely punctate or coarsely folliculated, follicles three to four follicle widths apart, tergum weakly depressed basally; metasomal sterna dull, very densely, finely folliculated; seventh ventral plates with broad, membranous apical expansions (fig. 68).

*Female:* length 9.5 mm., wing length 6.5 mm.

Pile of face short and dense, particularly about antennal bases and along lower inner orbital margins; a few, long, white hairs on clypeus; vertex with pile pale grey, particularly in ocellar triangle; genal areas with upper surface having abundant, short, pale grey pile, becoming very long and fine below; mesoscutum with an admixture of white and black pile, black pile concentrated principally on median discal area; scutellum with a narrow fringe of whitish pile about lateral and posterior margins, abundant black pile on disc; mesepisterna with pile long, fine, white; propodeum with rather dense, long, white fringes of pile at upper margin of latero-posterior margins, lateral and posterior faces with sparse, long, white pile; legs with pile long, white to tinged with grey and densely plumose on posterior femora; posterior tibiae with a weak admixture of very short, black pile on upper surface; first metasomal tergum with apical fascia weak, white, occasionally interrupted medially, lateral fringes of pile very weak, barely extending to apical fascia, discal area with sparse, erect, white pile; metasomal terga two to five with fasciae broad and white; metasomal terga three to five with discs having abundant, very short, white, erect pubescence, not concealing surface; metasomal sterna with discs covered with abundant, erect, long pubescence, forming a strong scopa.

Antennae deep brown to black, flagellar segments short, five-eighths as long as broad; malar spaces short, one-eighth as long as broad to linear; clypeus weakly convex, very densely punctate over entire surface, punctures tending to weak striateness at apex with striae converging to medioapical margins; vertex shiny, sparsely punctate; fascial foveae deep, weakly broadened medially and extending one third of way to lateral ocelli. Prothoracic spines short and sharp; mesoscutum very densely and coarsely punctate, punc-

tures no more than one-half puncture width apart on anterior one half and lateral margin, impunctate area small; scutellum rather densely and coarsely punctate over posterior two thirds, punctures not at all striate and becoming weaker to absent on anterior face; mesepisterna very densely and coarsely, almost rugosely, punctate, separated by shiny ridges; propodeum with basal area sloping ventrally and with shallow, linear, quadrate pits, lateral and posterior faces dull and roughened; tegulae deep brown hyaline; wings dusky with abundant, short, fulvous pubescence, particularly on apical portions, nervures dark brown; legs deep brown to black; posterior basitarsi three times as long as broad. First metasomal tergum shiny, very weakly and sparsely folliculated, follicles three to six follicle widths apart; second metasomal tergum shiny with follicles much closer than on first, follicles approximately two to four follicle widths apart; metasomal sterna dull, very densely and finely folliculated, last metasomal sternum with apical one fourth sharply depressed and shiny with a fringe of long, tawny pile overhanging from apical margins.

*Distribution:* Holotype male, allotype female, 12 male and 1 female paratypes: Alfred, Texas, March 29, 1951 (R. H. Beamer and C. D. Michener) on *Acacia greggi;* additional paratypes: 6 males, Southmost, Cameron County, Texas, March 27, 1951 (R. H. Beamer and C. D. Michener) on *Coreopsis douglasii;* 2 males, 1 female, Albany, Texas, April 9, 1950 (Beamers, Stephen, Michener, Rozens) on *Rhus microphylla*; 3 males, Quemada, Texas, April 14, 1949 (Michener and Beamer); 2 males, Austin, Texas, April 12, 1902 (A. L. Melander); 1 female, 23 miles south Del Rio, Texas, April 11, 1950 (Michener, Rozens, Beamers, Stephen) on *Prosopis glandulosa;* 1 female, Corrizo Springs, Texas, April 14, 1950 (Michener, Beamer); 1 female, 9 miles northwest Corrizo Springs, Texas, April 11, 1950 (Michener, Rozens, Beamers, Stephen) on *Chamaesaracha conioides;* 1 female, Hidalgo County, Texas, February 15, 1930; 1 female, Kerrville, Texas, April 14, 1907 (P. Durham) on *Marrubium vulgare;* 1 female, Tombstone, Texas, March 29, 1951 (L. D. Beamer); 1 female, San Antonio, Texas, February 28 (S. C. Pratt).

Other material not included in the type series: 1 male, Meade County State Park, Kansas, June 7, 1950 (H. O. Wright); 1 male, Johnson, Kansas, June 16, 1949 (Michener and Beamer) on *Quincula lobata.*

The holotype and allotype are in the Snow Entomological Collections of the University of Kansas.

### *Colletes linsleyi* Timberlake

*Colletes linsleyi* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 205.

This is a monotypic species described by Timberlake from a female taken at Blythe, California. It is recognizable as a member of the *consors* group in having the last metasomal sternum with the apical portion sharply depressed. The female closely resembles that of *swenki* but has the first metasomal tergum densely folliculated and the fascial foveae much broader.

*Female:* length 8 mm., wing length 5 mm.

Pile of face short, sparse, and white, most dense along inner orbital margins; vertex with pile light grey and sparse; upper genal areas with short, light grey pile, becoming whiter, longer, and finer below, a weak rim of semiappressed white pubescence posterior to each compound eye; mesoscutum and scutellum with mixture of white, dusky, and black pile, black pile principally on median discal areas; mesepisterna with pile sparse, fine, and white; propodeum with long fringes of grey pile on lateroposterior margins, extending down to pedicel posterior face with abundant, erect, light grey pile; pile of legs long, plumose, and tinged with ochreus except on posterior tibiae where there is abundant, short, black pile; first metasomal tergum with weak fascia of short white pubescence, fascia interrupted medially, lateral fringes absent, a few, long, erect, white hairs on extreme anterior face of disc; fasciae of metasomal terga two to four weak, composed of short white pubescence, often interrupted medially; metasomal terga two to five having abundant, very short, dark black, erect pubescence on discal areas; metasomal sterna with abundant, erect, fulvous pubescence over each disc, forming a weak scopa.

Antennae reddish brown, flagellar segments one-half as long as broad; malar spaces linear; clypeus weakly and uniformly convex, very densely punctate with weakly rugose punctures, punctures becoming much more striate at lateroapical margins; vertex shiny, finely and rather densely punctate; fascial foveae very deep, broadened medially and extending well up beyond dorsal to inner orbital margins, extending almost half way to lateral ocelli. Prothoracic spines blunt and vestigial; mesoscutum densely, contiguously punctate over anterior one-half and lateral margins, impunctate area small; scutellum coarsely and densely punctate over posterior three fourths, anterior median area shiny, impunctate; mesepisterna dull, closely and densely punctate with coarse punctures; propodeum with basal area sloping sharply posteriorly, very shallowly, quad-

rately pitted, lateral and posterior faces dull and roughened; tegulae deep brown hyaline; wings dusky, very densely covered with short, fulvous pubescence, nervures deep brown; legs deep reddish brown; posterior basitarsi three and one-half times as long as broad. First metasomal tergum shiny, very densely and finely folliculated over entire surface, follicles almost appearing as a weak roughness to the surface; metasomal terga two and three similarly finely and very densely folliculated, dull; metasomal sterna dull, densely, rather coarsely folliculated; last metasomal sternum with apical one-fourth depressed, shiny, and nonplumose, with a basal fringe of long, overhanging, fulvous pile.

*Distribution:* California: Blythe, Riverside County, May 7, 1947, on *Tamarix* (E. G. Linsley) (holotype).

The holotype is at the Citrus Experiment Station, Riverside, California.

### Group XIV—*intermixtus*

### *Colletes intermixtus* Swenk

(Fig. 70)

*Colletes intermixtus* Swenk, 1905, Canadian Ent., vol. 37, p. 302; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 42; Cockerell, 1917, J. New York Ent. Soc., vol. 25, p. 189; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 399; 1951, Wasmann J. Biol., vol. 9, p. 207.
*Colletes lippiarum* Cockerell, 1909, Canadian Ent., vol. 41, p. 394; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 399.

This species is not uncommon in the lower Sonoran zone of America from Texas to California and occurs to a lesser degree in western Colorado. Both sexes have the clypeus long and flattened, with a distinct longitudinal median sulcus; the antennae, while not as short as in the members of the *consors* group, are shorter than in representatives of other groups. The males have the malar spaces about two-thirds as long as wide; black pile on the mesoscutum and the scutellum, and an impunctate first metasomal tergum; the seventh ventral plates are rather distinctive, as illustrated. The females also have the first metasomal tergum impunctate, and have abundant black pile on the inner orbital margins, the clypeus, genal areas, as well as the thoracic dorsum; the malar spaces are approximately one-third as long as wide and the fascial foveae are deep and elongate.

*Male:* length 10 mm., wing length 6.75 mm.

Pile of face long and dense, particularly about antennal bases and inner orbital margins; clypeus only weakly concealed by overhanging white pile; vertex with pile long, sparse, and pale grey; upper genal

areas with pile long and tinged with pale grey, becoming longer, denser, and whiter below; mesoscutum with pile predominantly long, fine and pale grey, a few black hairs intermixed on median discal area; scutellum with a weak lateral and posterior fringe of long, pale grey pile, abundant black pile mesad to this peripheral rim; mesepisterna with pile long, fine, and white; propodeum with long fringes of white pile along upper lateroposterior margins; pile of legs sparse, pale grey, and fine; first metasomal tergum with apical fascia narrow, dense, and white, weak lateral fringes of white pile barely reaching apical fascia, discal area with abundant, erect, whitish pile, not concealing surface; metasomal terga two to five with fasciae rather narrow and dense, narrowed laterally, white; metasomal terga three to six with abundant, erect, deep fulvous to black pile on discs; metasomal sterna with lateral fringes of long, light ochreus pile, broadly interrupted medially.

Antennae deep brown to black, flagellar segments approximately one and one-fourth times as long as broad; malar spaces about one-half as long as broad; clypeus weakly convex with a deep longitudinal median sulcus extending from base to apex, clypeus rather sparsely and coarsely punctate, with shiny interspaces, apical and lateroapical faces shiny and very sparsely punctate; vertex shiny, finely and sparsely punctate. Prothoracic spines very short, vestigial; mesoscutum densely punctate over anterior and lateral margins, impunctate area small; scutellum rather finely and densely punctate over posterior one half, punctures fine, sparse to absent on anterior one half; mesepisterna distinctly punctate with shiny interspaces, punctures one-half puncture width apart; propodeum with basal area shallowly, quadrately punctate, lateral and posterior faces shiny and sharply punctate, punctures one to four puncture widths apart; tegulae black; wings dusky with abundant, fine, fulvous pubescence; nervures deep brown; legs black; posterior tibiae greatly expanded on median anterior margins, almost bulbous; posterior basitarsi two and one-half times as long as broad. First metasomal tergum very finely and sparsely punctate, almost folliculated, interspaces shiny and tinged with a metallic blue lustre; second metasomal tergum black, rather densely folliculated; metasomal sterna dull; apical metasomal sternum winged weakly on lateroapical margins; seventh ventral plates roughly triangular with lateral and median margins reflexed, apical margin weakly emarginate and dense clumps of pile at each of reflexed apical and median margins (fig. 70).

*Female:* length 9.5 mm., wing length 6.5 mm.

Pile of face long and white about antennal bases and along inner orbital margins, a few darker hairs intermixed along lower inner orbital margins; vertex with a few dark hairs amongst fine, long, fulvous pile; upper occiput with pile short and pale grey, pile becoming much longer and whiter below, weak, appressed rim of white pubescence immediately posterior to each compound eye; mesoscutum with pile predominantly pale grey but with a strong admixture of black pile on discal area; scutellum with a mixture of pale grey and black pile about lateral and posterior margins; mesepisterna with pile long, fine, and white; propodeum with long fringes of white pile on upper lateroposterior margins, occasionally a few black hairs intermixed on extreme upper face; legs with pile long, rather dense, and tinged with ochreus, a number of short black hairs on upper surface of posterior tibiae; first metasomal tergum with a very narrow, yet dense fringe of white pubescence on apical margin, a weak fringe of white pile almost reaching the apical fascia, disc with abundant, fine, erect, white pile; metasomal terga two to four with fasciae broad, rather weak, and pure white, discal area with abundant, very short, fine, erect, black pile; metasomal sterna with discs having abundant, erect, white to pale grey pile on discs, forming a very weak scopa.

Antennae brown to black, flagellar segments five-eighths as long as broad; malar spaces one-third as long as broad; clypeus weakly convex with a deep longitudinal median sulcus, surface coarsely and sparsely striately punctate, punctures densest along longitudinal median sulcus, tending to be two to five puncture widths apart on lateral faces, interspaces shiny; vertex shiny, impunctate; fascial foveae expanded mediately, deeply depressed and bluntly rounded, dorsally, dorsal margin not extending half way to lateral ocelli. Prothoracic spines roughly triangular, approximately as long as width across base; mesoscutum very densely and coarsely punctate about anterior and lateral faces, impunctate area very small; scutellum distinctly punctate over posterior one half, not striately punctate, punctures becoming very sparse on anterior one-half; mesepisterna deeply and densely punctate, with shiny interspaces, punctures one-half puncture width apart; propodeum with basal area shallowly, quadrately pitted, lateral and posterior faces dull, sharply punctate, punctures two to four puncture widths apart; tegulae deep brown to black; wings dusky with abundant, short, fulvous pubescence, nervures dark brown; legs deep brown to black; posterior basitarsi three times as long as broad. First metasomal ter-

gum moderately shiny and very finely folliculated, surface with a weak, metallic blue lustre; second metasomal tergum dull, very finely and densely folliculated; metasomal sterna dull, densely folliculated.

*Distribution:* Texas: 36 miles south of Sonora; San Benito; 47 miles west of Sheffield; San Antonio; Bexar County; Dimmit County; Fedor, Lee County; Cotulla; Goliad County; Austin; Southmost, Cameron County; Big Bend; Chisos Mountains, Big Bend National Park; Ben Bolt; Kerrville. Colorado: Grand Junction. California: Riverside; Redlands; Imperial County; Wood Lake, Tulare County; The Colorado Desert; Colton; Lindsay. Arizona: Oak Creek Canyon.

Cockerell records the species (as *lippiarum*) from La Cueva, Organ Mountains, New Mexico. I have not seen any material from that state but the species undoubtedly occurs there.

*Flight records:* The species has been recorded from March 28 in southern Texas to September 20 in southern California. The collected material would indicate the species flies throughout the summer, having been taken in every month from March until September in both Texas and California.

*Plant records: Cotoneaster, Ericamera palmeri, Eriogonum fasciculatum, Gnaphalium beneolens, Gutierrezia, Monarda citriodora, Physalis, Schinusmolle, Solanum douglasii.*

Swenk states the species visits the flowers of *Acacia farnesiana* and Cockerell records it on *Koeberlinia spinosa* and *Lippia wrightii.*

The holotype of *intermixtus* from Fedor, Lee County, Texas, is in the collections of the University of Nebraska, and that of *lippiarum* from La Cueva, Organ Mountains, New Mexico, is in the Citrus Experiment Station, Riverside, California.

*Colletes bulbotibialis* sp. nov.

(Fig. 71)

This unique specimen closely resembles *C. intermixtus* Swenk but can readily be distinguished from the latter by the absence of black pile on the mesoscutum and scutellum. A distinctive feature of *C. bulbotibialis* is the bulbous form of the tibiae, particularly the hind pair which are broadly distended medially and constricted basally and apically. The posterior basitarsi are peculiar in being longitudinally curved.

*Male:* length 8 mm., wing length 5.5 mm.

Pile of face long, white, and moderately dense about antennal bases and along lower inner orbital margins, a few, long, pale grey

hairs overhanging clypeus from clypeofrontal margin; clypeus with a few, sparse, pale grey to white hairs, particularly along median discal area, pile not at all concealing surface; vertex with a sparse covering of erect, pale grey pile, genal areas with pile short, fine, and pale grey, becoming much longer and whiter below; mesoscutum with abundant, long, fine, pale grey to dusky pile over entire surface, pile sparse and not concealing surface, mesoscutum with a dense fringe of long, tawny-dusky pile about lateral and posterior margins, with a few hairs overhanging median discal area; mesepisterna with pile long, fine, and white; propodeum with long fringes of white pile along lateroposterior margins, fringes most dense and longest on dorsal margins, laterial and posterior face with a sparse covering of erect, whitish pile, a few, short, appressed hairs on the lateral faces; pile of legs long, fine, white to pale grey, and sparse; first metasomal tergum with a narrow apical fascia of white pubescence, lateral fringes of white pile extending to apical fascia, disc with a sparse covering of erect, whitish pile, particularly over anterior surfaces; metasomal terga two to five with fasciae broad, weak, and white, fasciae of terga two and three weakly interrupted medially; metasomal terga three to six with discs having an intermixture of short dark and long pale grey pile; metasomal sterna one to three with weak apical fringes of pale grey to dusky pile, sterna four and five with fringes most evident as lateral tufts of dusky pile.

Antennae long, deep brown to black, flagellar segments one and one-fourth times as long as broad; malar spaces three-fourths as long as broad; clypeus long with a distinct median longitudinal sulcus, surface sparsely and finely punctate, tending to be very weakly striate apically, punctures most dense along median sulcus, lateral rims with punctures two to three puncture widths apart, with broad, shiny interspaces; vertex sharply punctate with shiny interspaces, punctures one to three puncture widths apart. Prothoracic spines absent; mesoscutum densely and coarsely punctate over anterior and lateral margins, punctures no more than one-half puncture width apart, impunctate area small; scutellum shallowly and rather obscurely punctate about lateral and posterior margins, punctures becoming much finer and smaller over median discal area where they are one to two puncture widths apart; mesepisterna densely and coarsely punctate, punctures almost contiguous above to one-half puncture width apart below; propodeum with basal area broad with numerous longitudinal quadrate pits, lateral and posterior faces shiny, weakly roughened, and obscurely punctate;

tegulae black; wings dusky with abundant, deep fulvous pubescence, nervures dark brown; legs dark brown to black, tibiae bulbous towards medioapical extremity, base and apex sharply constricted; posterior basitarsi short and weakly curved, three and one-half times as long as broad. First metasomal tergum finely punctate, punctures one to three puncture widths apart, being most sparse medially; second metasomal tergum finely and densely punctate, punctures approximately one puncture width apart, second metasomal tergum weakly depressed basally and apically, depressions most evident laterally; metasomal sterna shiny, finely and sparsely folliculated; last metasomal sternum shallowly concave, concavity longitudinally bisected by a weak median elevated rim; seventh ventral plates transverse with apical margins broadly arcuate (fig. 71).

Holotype, male, Belen, New Mexico, August 19, 1927 (P. A. Readio).

The type is in the Snow Entomological Collections of the University of Kansas.

### GROUP XV—*ciliatus*

### *Colletes ciliatus* Patton

(Fig. 72)

*Colletes ciliata* Patton, 1879, Bull. U. S. Geol. and Geog. Survey, ser. 5, no. 3, p. 369.

*Colletes speciosa* Robertson, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 62; 1904, Canadian Ent., vol. 36, p. 275; 1928, Flowers and Insects, p. 10 (new synonymy).

*Colletes brevihirtus* Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 395 (new synonymy).

Although the loss of the Patton types makes positive verification impossible, I believe that the better known *speciosus* Robertson is the same as *ciliatus* Patton. After a critical examination of the original description, the flight period and locale, it is not possible to confuse this for any other species. The description of *brevihirtus* Timberlake agrees closely with the male of *ciliatus*, a synonymy which has been verified by Mr. Timberlake upon the examination of the male of *speciosus*.

The species is closely related to *beamerorum*, and is characterized by the very small preapical ventral wings of the penis valves in the male, by the very short malar spaces and by the weakly convex and densely punctate clypeus in both sexes.

*C. ciliatus* is sparsely distributed over America east of the Rocky Mountains from Colorado to Virginia, and this paper includes the

first published record of the male of the species, although a male had been identified in the Swenk collection.

*Male:* length 10 mm., wing length 6.5 mm.

Pile of face very dense, short, and completely concealing clypeal area, sub- and supra-antennal areas up to median ocellus, pile strongly tinged with ochreus; vertex with pile concentrated principally in ocellar triangle, strongly tinged with ochreus; genal areas with upper surface having abundant, long, erect, light ochreus pile, pile becoming finer, longer, and whiter below; mesoscutum with abundant, short, erect, light ochreus pile; scutellum with a very broad lateral and posterior band of ochreus pile; mesepisterna with upper half having pile tinged with ochreus, pile much whiter, longer, and finer on lower surfaces; propodeum with long fringes of light ochreus pile on upper lateroposterior margins, lateral and posterior faces with sparse, erect, light ochreus pile; legs with pile short, sparse, and pale grey, femora with longer fringes of plumose, pale grey pile; first metasomal tergum with apical fascia narrow, rather weak, and tinged with yellow, lateral fringes very weak, barely reaching apical fascia, disc with abundant, short, erect, grey to light ochreus pile on the extreme anterior face, median discal area with pile very short and fine, virtually invisible except when viewed laterally; metasomal terga two to five with fasciae narrow, weak, and lightly tinged with light ochreus; metasomal terga five and six with a very sparse covering of short, deep fuscous pile; metasomal sterna two to four with weak fringes of long, pale grey pile.

Antennae reddish brown to deep brown, flagellar segments one and one-fourth times as long as broad; malar spaces very narrow, one-fourth as long as broad; clypeus weakly convex, very densely and finely punctate over entire surface, dull; vertex finely and densely punctate, dull. Prothoracic spines absent; mesoscutum densely, finely, and shallowly punctate over the anterior, lateral, and posterior margins, impunctate area absent; scutellum with discal area finely, shallowly punctate with shiny interspaces, punctures one-half to one puncture width apart, extreme anterior face shiny, impunctate; mesepisterna dull, very closely, finely, shallowly punctate, punctures no more than one-half puncture width apart; propodeum with basal area narrow, shallowly, quadrately pitted, lateral and posterior faces dull; tegulae light hyaline brown; wings dusky with abundant, very deep fulvous pubescence, particularly on apical half, nervures brown; legs brown to black, tarsi tending to be light

brown; posterior basitarsi four times as long as broad. First metasomal tergum very finely and densely punctate, with interspaces rather dull, punctures approximately one puncture width apart; second metasomal tergum punctured much as first, only with punctures still more folliclelike, surface dull; metasomal sterna dull, finely folliculated; seventh ventral plates much as in *texanus,* however being almost completely semicircular, rather densely covered with deep brown pubescence (fig. 72).

*Female:* length 11 mm., wing length 7 mm.

Pile of face short and dense along inner orbital margins and in supra-antennal areas; a very weak covering of short white pile on clypeus, pile tinged weakly with light yellow; vertex with pile long and tinged with light ochreus, particularly in ocellar triangle; upper genal areas with pile dense, long, and tinged with yellowish, pile becoming much longer, finer, and whiter below, a very narrow rim of appressed, whitish pubescence immediately posterior to each compound eye; mesoscutum with abundant, erect, short, light ochreus pile; scutellum with a broad fringe of short, light ochreus pile about lateral and posterior faces; mesepisterna with abundant, long, fine pile, pale grey to dusky above, becoming pure white below; propodeum with dense fringes of long, light ochreus pile along lateroposterior margins, being most dense dorsally, lateral and posterior faces sparsely covered with long, erect, pale grey pile; pile of legs longest on femoral fringes, white pile on anterior two pairs of legs, pile much longer and exceedingly plumose on posterior femora and tibiae, where it is also tinged with light yellow; first metasomal tergum with apical fascia narrow and white, often interrupted medially, lateral fringes of very short, white pile, barely reaching the apical fascia, extreme anterior face of disc with sparse, very short, whitish pile; metasomal terga two to five with fasciae broader, weak, and white; metasomal tergum five with disc having a weak covering of erect, deep fuscous to dark brown pile; metasomal sterna virtually bare except for a few, erect, light hairs.

Antennae brown, flagellar segments about as long as broad; malar spaces one-eighth as long as broad; clypeus short, weakly convex, very densely and finely punctate to apex; vertex finely and densely punctate, dull; fascial foveae weakly depressed extending medially two fifths of way from inner orbital margins to lateral ocelli. Prothoracic spines absent; mesoscutum very densely, almost contiguously punctate about anterior, lateral, and posterior margins, impunctate area absent, median discal area with punctures sparser and

more sharply delineated; scutellum very densely contiguously punctate about lateral and posterior margins, discal area having punctures more apparent but very shallow and close, usually less than one-half puncture width apart; mesepisterna dull, very finely and densely punctate and contiguous over upper surfaces; propodeum with basal area very narrow, shallowly, quadrately pitted, lateral and posterior faces dull; tegulae light hyaline; wings dusky with abundant, short, fulvous pubescence, nervures light brown; legs brown; posterior basitarsi 3.8 times as long as broad. First metasomal tergum very finely and densely punctate, punctures no more than one puncture width apart; second metasomal tergum punctured much as first, with punctures finer, surfaces dull; metasomal sterna shiny, very finely roughened with a few coarser follicles on apical half of each sternum.

*Distribution:* Four miles south of Lawrence, Douglas County, Kansas, August 25, 1949 (Michener, Beamer) on *Cuscuta* (neotype, female, neallotype male, and four additional females); Lincoln, Nebraska, August; Sioux City, Iowa, April 19 (C. N. Ainslie); Carlinville, Illinois; Alexandria, Virginia, September 9, 1928 (C. E. Mickel); and Wray, Colorado, August 17-19, 1919.

The neotypes are in the Snow Entomological Collections of the University of Kansas, the holotype of *speciosus* from Carlinville, Illinois, is in the Illinois Natural History Survey, and the holotype of *brevihirtus* from Wray, Colorado, is in the American Museum of Natural History.

### *Colletes ciliatoides* sp. nov.

(Fig. 74)

This is a sibling species of *C. ciliatus* Patton but can readily be distinguished from that species in having long prothoracic spines, approximately one and one-fourth times as long as the width across the base, and in the distinctive features of the genitalia. The seventh ventral plates of this species are longer than broad and are indistinctly bilobate with the lateral lobe much smaller than in *ciliatus* and incomplete; the penis valves have narrow ventral membranous margins, which are completely absent in *ciliatus*. The body of this species is very closely and coarsely punctate with the punctures contiguous to one-half puncture width apart on the mesoscutum, mesepisterna, and first metasomal tergum.

*Male:* length 9.5 mm., wing length 6.5 mm.

Pile of face long, dense, and completely concealing clypeus and antennal basal regions as far as median ocellus, pile pale grey be-

coming progressively more tinged with yellow towards dorsal surface; vertex with pile tinged with light ochreus, concentrated principally in ocellar triangle; genal areas with pile dusky above, becoming much longer, finer, and whiter below, a narrow rim of appressed, white pubescence immediately posterior to each compound eye; scutellum with a dense covering of fulvous to light ochreus pile; scutellum with a lateral and posterior rim of long, dusky to light ochreus pile with a few longer hairs overhanging and partially concealing median discal area; mesepisterna with pile long, fine, and pale grey; propodeum with long fringes of light ochreus pile along lateroposterior margins, fringes most dense and longest on dorsal surface, lateral faces with a weak covering of short, appressed pubescence partially obscuring surface, posterior face with a sparse covering of long, erect, dusky pile; pile of legs short and sparse except on femora which have longer fringes of white pile; first metasomal tergum with a broad fascia of pale grey pubescence, lateral fringes of pile tinged with yellowish extending to apical fascia, disc with abundant, long, dusky pile, particularly on anterior face; metasomal terga two to five with fasciae broad, weak, and tawny; metasomal terga four to six having the discs with abundant, short, erect, black pile; metasomal sterna one to five with weak apical fringes of dusky pile.

Antennae long, brown to deep brown, flagellar segments one and one-fourth times as long as broad; malar spaces three-eighths as long as broad; clypeus weakly convex, very finely and densely punctate to apical margins; vertex shiny, finely punctate with shiny interspaces. Prothoracic spines long and sharp, approximately one and one-half times as long as width across base; mesoscutum coarsely and densely punctate, punctures no more than one-half puncture width apart about anterior one-half and lateral margins, impunctate area very small; scutellum densely, contiguously punctate about lateral and posterior margins, punctures becoming very coarse with shiny interspaces on posterior portion of discal area, extreme anterior margin shiny, impunctate; mesepisterna coarsely and densely punctate, punctures contiguous above to one-half puncture width apart below; propodeum with basal area shallowly, quadrately pitted, lateral and posterior faces shiny and irregularly punctate, punctures closest on upper lateral margins, becoming very sparse on posterior face; tegulae light brownish hyaline; wings dusky with abundant, deep fuscous pubescence over surface, nervures dark brown; legs brownish black basally, grading to light

brown apically; posterior basitarsi four and one-half times as long as broad. First metasomal tergum densely and rather coarsely punctate, punctures no more than one-half puncture width apart laterally, tending to become somewhat finer and sparser toward median and anterior faces where they may be one puncture width apart; second metasomal tergum densely and finely punctate with punctures no more than one puncture width apart, punctures much finer than those of first tergum, tergum with an abrupt basal depression; metasomal sterna shiny, finely and sparsely folliculated, particularly on apical one half of each segment; last metasomal tergum with apex broadly rounded; seventh ventral plates longer than broad, weakly bilobate with lateral lobe rudimentary and short, median and lateral margins strongly reflexed, roughly resembling plates of *C. thoracicus;* penis valves with narrow ventral membranous rims (fig. 74).

*Distribution:* Holotype, male, and two male paratypes, Delta, Utah, August 5, 1948 (G. E. Bohart) taken on dodder (*Cuscuta*).

The type of this species is in the collections of the United States National Museum.

*Colletes beamerorum* sp. nov.

(Fig. 73)

This species, of which only the males are known, has the antennal segments one and one-fourth times as long as broad and no dorsal convolutions to the penis valves; otherwise, on the basis of the seventh ventral plates, it closely resembles *texanus* and its relatives of the *consors* group. It is arbitrarily placed here until the female is collected, which may then clarify its position.

The clypeus is convex and densely punctate, much as in the females of *linsleyi* and the males of *swenki.* The malar spaces are short, one-fourth as long as broad. The first metasomal tergum is densely punctate with punctures one to two puncture widths apart. There is no dark pile on the body.

*Male:* length 9 mm., wing length 6 mm.

Pile of face dense, completely concealing clypeus and antennal bases, tinged with light yellow; vertex with pile tinged with light ochreus, concentrated principally in ocellar triangle; upper genal areas with pile short and tinged with yellow, becoming longer, finer, and whiter below; mesoscutum with pile dense, rather short, and tinged with light ochreus; scutellum with a dense lateral and posterior fringe of ochreus pile, a few deeper ochreus hairs

intermixed towards median discal surface; mesepisterna with pile tinged with light yellow above, becoming pure white below, pile fine, long, and weakly plumose; propodeum with rather long fringes of dense, light ochreus pile, particularly on dorsal lateroposterior margins, however extending down lateroposterior margins toward pedicel, lateral and posterior faces with sparse, erect, pale grey pile; pile of legs sparse, weak, and white, most dense as fringes of white pile to femora; first metasomal tergum with apical fascia rather broad and dusky, often interrupted weakly medially, lateral fringes of long, dusky pile extending to apical fascia, disc with sparse covering of erect, tawny pile; metasomal terga two to five with fasciae broad, weak, and pale grey; metasomal sterna two to five with long fringes of dusky pile on extreme apical margins.

Antennae long, brown to brownish black, flagellar segments one and one-fourth times as long as broad; malar spaces one-fourth as long as broad; clypeus convex and short, finely and densely punctate over entire surface, punctures becoming weakly striate on the lateral and lateroapical margins with very narrow, linear interspaces; vertex densely punctate, dull, with narrow interspaces. Prothoracic spines very short and sharp; mesoscutum densely punctate over anterior and lateral margins, punctures becoming sparser and slightly larger toward median discal area where they tend to be one to two puncture widths apart, impunctate area small; scutellum with posterior one half rather densely punctate, punctures becoming sparser and shallower on anterior one half, anterior one third shiny, impunctate; mesepisterna densely and coarsely punctate, interspaces linear and shiny, punctures no more than one-half puncture width apart; propodeum with basal area narrow and broadly, quadrately pitted, lateral and posterior faces shiny, rugose along lateroposterior margin with lateral and posterior faces irregularly punctate; tegulae deep brownish hyaline; wings dusky with abundant, deep fulvous pubescence, particularly on apical two-thirds; legs deep brown to black; posterior basitarsi four times as long as broad. First metasomal tergum very densely punctate with narrow, shiny interspaces, punctures one-half puncture width apart, being slightly sparser medially and anteriorly; second metasomal tergum punctured much as first, only with punctures appearing more folliclelike and just appreciably denser; metasomal sterna shiny, rather finely and moderately densely folliculated; seventh ventral plates roughly semilunar in shape and similar to those of *texanus,* however differing in pubescent covering, penis valves with no dorsal convolution, otherwise resembling *texanus* (fig. 73).

*Distribution:* Holotype, male, and 20 male paratypes: Catarina, Texas, April 11, 1950 (Michener, Rozens, Beamers, Stephen) on flowers of *Monarda punctata coryi;* one male paratype, Brownsville, Texas, October 16, 1908 (Mitchell and Bishopp); 1 male paratype, Paris, Texas, June 22, 1905 (F. C. Bishopp); 2 male paratypes, Juarez, Chihuahua, Mexico, August 26 (T. D. A. Cockerell).

The holotype is in the Snow Entomological Collections of the University of Kansas.

## Group XVI—*daleae*

### *Colletes daleae* Cockerell

(Fig. 80)

*Colletes daleae* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 43; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 24; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; 1924, Proc. California Acad. Sci., ser. 4, vol. 12, p. 531 and 536; 1925, Proc. California Acad. Sci., ser. 4, vol. 14, p. 186; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 235.

The species ranks in size with *prosopidis* but is usually slightly larger. The males are difficult to distinguish from *salicicola* but can usually be separated by having the malar spaces approximately one and one-half times as long as wide, and in having the flagellar segments about one and one-third times as long as wide. The metasomal terga are strongly tinged with blue, giving them a distinct metallic blue lustre. The seventh ventral plates are distinctive in having short lateral fringes of pile, as well as a clump of pile on each arising at the upper surface immediately beneath the articulatory condyle. The mesepisterna are usually shallowly or obscurely punctate; however in some of the more northerly specimens the punctation becomes rather distinct. The females may also be difficult to separate from *salicicola* but are slightly shorter and have the disc of the sixth metasomal tergum with deep ferrugineous to dark brown pile. The species can be separated from *deserticola* in being much shorter and in having longer malar spaces.

*Male:* length 6.5 mm., wing length 5 mm.

Pile of face long, dense, and pure white, completely concealing clypeus, lower inner orbital margins with little appressed pubescense; ocellar triangle and vertex with a few pale grey hairs; upper genal areas sparsely pilose with pale grey pile, becoming pure white and much denser on lower and posterior surfaces, a broad rim of appressed pubescence immediately posterior to compound eyes; mesoscutum with sparse covering of light ochreus to pale grey pile

not concealing surface; scutellum with long, weakly plumose pile about lateral and posterior edges; metanotum sparsely covered with a few, long, erect hairs; posterior lobe of pronotum with a clump of sparse, white pile; mesepisterna sparsely pilose with pale grey to white pile; propodeum with weak fringes of white pile on dorsolateral edges, lateral and posterior faces sparsely covered with long, erect pile; legs with short, sparse, white pile; first metasomal tergum sparsely covered with fine, pale grey pile, lateral fringes weak to absent, discernible if viewed dorsally; apical fasciae broad and white, first metasomal fascia narrowed slightly medially; metasomal terga four and five having discs covered with short, sparse, light golden pile; sternal fasciae weak and white.

Antennae short, deep reddish brown, flagellar segments about one and one-third times as long as wide; malar spaces one and one-half times as long as wide; clypeus strongly protuberant with a distinct longitudinal median sulcus which is broadened apically, sulcus finely and densely punctate, lateral rims of sulcus shiny with a few, scattered, coarse punctures, extreme base and lateral edges finely and densely punctate; vertex closely and densely punctate. Prothoracic spines absent; mesoscutum shiny and sparsely punctate with shallow punctures, punctures close on extreme anterolateral margins; scutellum shiny and finely punctate on posterior margins; mesepisterna shiny but roughened due to obscure punctures over surface; propodeum with lateral and posterior faces dull and roughened, basal area with many weak longitudinal rugae; tegulae light hyaline brown; wings dusky with short, light ochreus pubescence especially on apical half, nervures yellow basally to light brown apically, stigma dark brown; legs black; posterior basitarsi short and slender, approximately four times as long as broad. Metasomal terga black, strongly tinged with blue giving surface metallic lustre; first metasomal tergum shallowly punctate giving surface roughened appearance at mid line, punctures more distinct laterally; second metasomal tergum finely folliculated with a broad, sharp basal depression; apical fasciae in sharp depressions tending to deep testaceous in color; metasomal sterna with apical margins entire; seventh ventral plates with long lateral fringes of pile as well as a clump arising on upper surface immediately beneath articulatory condyles, median discal area almost completely free of pile (fig. 80).

*Female:* length 8.5 mm., wing length 6.5 mm.

Pile of face dense and white, concentrated about antennal bases,

extending up to ocellar triangle, pile most dense and partially appressed along inner orbital margins, few long hairs at edge of clypeus partially obscuring lateral faces of clypeus; vertex with a few, scattered, pale grey to light ochreus hairs; upper genal areas with dense, short, white pile, becoming longer on lower and posterior faces, broad band of appressed, pure white pubescence extending from upper lateral faces of vertex to base of compound eyes immediately posterior to compound eyes; mesoscutum with abundant, short, plumose pubescence, slightly tinged with grey to light ochreus, concentrated principally over anterior half, lateral and posterior surfaces, leaving impunctate area bare; scutellum with dense lateral and posterior fringe of light ochreus, plumose pile; metanotum with pile long, loose, and plumose; pronotum with lateral faces partially concealed by appressed, white pubescence, posterior lobes covered with dense, white pile; mesepisterna with dense covering of plumose pile, tending to conceal character of surface, pile light grey; propodeum with long, white dorsolateral fringes of hair extending down towards pedicel, lateral faces partially concealed by appressed, white pubescence, posterior face with a few, erect, plumose hairs; legs with pile short and white, posterior femora with pile long, curved, and plumose, posterior tibiae with long, dense covering of pile; first metasomal tergum with scattered, white pile, most dense on upper anterior face, lateral fringes of dense, white pile most evident at extreme anterolateral face, fringes becoming very weak at junction of posterior edge and apical fascia; second metasomal tergum with dense basal fascia of white pile of equal width to apical fascia; third metasomal tergum with a weak, almost indistinguishable basal fascia; fasciae of terga broad and white; discs of metasomal terga four and five with scattered, white to ochreus pile; sixth metasomal tergum with deep ferrugineous, semiappressed pile; sternal fasciae absent.

Antennae short, deep reddish brown, flagellum black basally; malar spaces about seven-eighths as long as wide; clypeus shiny, strongly convex, median sulcus distinct, becoming broadened medially, sulcus with abundant fine punctation along median broadened area, lateral rims of sulcus shiny and sparsely punctate with coarser punctures; vertex shiny with a few scattered punctures. Prothoracic spines long and blunt, at least as long as broad at base; mesoscutum distinctly punctate about anterolateral and lateral edges, punctures no more than one puncture width apart, becoming much finer and sparser towards mid line and posterior edge, im-

punctate area large and shiny; scutellum with posterior one-third finely and densely punctate; mesepisterna coarsely and densely punctate, punctures almost contiguous but leaving narrow, shiny interspaces; propodeum with lateral and posterior faces weakly folliculated or roughened, basal area longitudinally transversed by numerous weak rugae; tegulae light brownish hyaline; wings dusky with abundant, light ochreus pubescence especially on apical portions, nervures yellowish basally becoming dark brown at apex, stigma brown; legs black; posterior basitarsi four times as long as wide. Metasomal terga shiny black strongly tinged with blue giving a metallic lustre; metasomal terga one and two impunctate; metasomal terga three, four, and five shallowly folliculated; second metasomal tergum with a very shallow basal depression; sterna with posterior margins entire.

*Distribution:* California: Victorville; Riverside; San Diego. Arizona: Tombstone; Sedonia. New Mexico: Albuquerque; Hot Springs; Carrizozo. Utah: Leeds; Kanab. Texas: El Paso.

*Flight records:* June 10 to July 4.

A single specimen labelled October 23 has been examined from San Domingo, Baja California. From this specimen it would appear that this species has two generations, one in summer, the other a late fall flier which may emerge only in the southern parts of the range.

*Plant records: Dalea scoparia; Eriogonum fasciculatum; Rhus laurina.*

The holotype from Mesilla Park, Las Cruces, New Mexico, is in the United States National Museum.

### *Colletes algarobiae* Cockerell

(Fig. 76)

*Colletes algarobiae* Cockerell, 1900, Entom., vol. 33, p. 244; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 45; Cockerell, 1924, Proc. California Acad. Sci., ser. 4, vol. 12, p. 532, 536; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 235.

The species, originally described from Mesilla Park, New Mexico, is sparsely distributed over the extreme southwestern United States and northwestern Mexico.

The males have the malar spaces approximately one and one-fourth times as long as broad, the mesepisterna closely and deeply punctate above, and the seventh ventral plates slightly broadened apically and abruptly truncate with the inner apical margins strongly reflexed.

The females are readily distinguished by the characters employed in the key.

*Male:* length 8 mm., wing length 6 mm.

Pile of face short and dense, particularly along lower inner orbital margins, about antennal bases, and along upper edge of clypeus; vertex with a few white hairs in ocellar triangle; upper genal areas with few, scattered, pale grey hairs, becoming denser, longer, and whiter below and on posterior surfaces, a weak band of short, appressed pubescence immediately posterior to compound eyes; mesoscutum with sparse covering of long, fine, pale grey hairs; scutellum with weak lateral and posterior fringes of pale grey pile, not concealing surface; metanotum with dense covering of long, weakly plumose hairs; mesepisterna with a few, sparse, long, pale grey hairs; propodeum with dorsolateral edges having long fringes of white pile extending halfway down to pedicel, lateral and posterior faces sparsely pilose; legs with short, sparse, white pile; first metasomal tergum with anterior face and disc sparingly pilose with short white pile, lateral fringes weak, evident only at extreme anterolateral edge of disc, fascia narrow and weak; metasomal terga two to four with fasciae very broad but weakly covered with short white pubescence, fasciae broadest laterally; metasomal terga three to five with discs sparsely covered with short, fine, white pile; metasomal sterna with weak apical fasciae evident only at lateral edges.

Antennae deep reddish-brown, becoming black basally, flagellar segments one and one-half times as long as broad; malar spaces one and one-fourth times as long as broad; clypeus strongly protuberant with a shallow, broad longitudinal median sulcus, sulcus finely and densely punctate along entire length, lateral rims shiny, sparsely punctate with weak punctures, extreme lateral and dorsal edges of clypeus finely and densely punctate; vertex shiny, impunctate. Prothoracic spines short and sharp; mesoscutum shiny, weakly and sparsely punctate, almost folliculated, punctures most dense along anterolateral margin; scutellum shiny impunctate, except in having posterior margin roughened; metanotum shiny impunctate; mesepisterna closely and densely punctate above, punctures becoming shallow and obscure on central discal areas, about one to two puncture widths apart; propodeum with lateral faces shiny, roughened over posterior surfaces, basal area weakly longitudinally striate; tegulae light brownish hyaline; wings dusky with abundant light ochreus pubescence most evident at apex; nervures and stigma light brown; legs reddish-brown, blackened basally, tending to light brown at apex; posterior basitarsi five times as long as broad. First metasomal tergum shiny, finely and sparsely punctate, almost folliculated; second metasomal tergum shiny and sparsely folliculated,

with a sharp basal depression; metasomal terga one to four with apical fasciae in sharp depressions, depressed areas a light testaceous hyaline; metasomal sterna with posterior margins entire; seventh ventral plates broadened slightly apically and abruptly truncate, inner apical margins strongly reflexed, dense fringes of pile along lateroapical and medioapical margins (fig. 76).

*Female:* length 9 mm., wing length 6.5 mm.

Pile of face pure white, pile erect about antennal bases and slightly appressed along inner orbital margins, a few, long, pale grey hairs extending from frontoclypeal margin over surface of clypeus; ocellar triangle with clump of light ochreus pile; upper genal areas covered with short white pile, becoming much longer and sparser on lower and posterior surfaces, a broad rim of appressed white pubescence immediately posterior to compound eyes, broadest ventrally; mesoscutum covered with short, dense, light ochreus pile; scutellum with lateral and posterior edges densely rimmed with light ochreus pile; metanotum with sparse covering of tawny to light ochreus pile; posterior lobe of pronotum densely concealed by a clump of pure white pile; mesepisterna sparsely covered with long, erect, weakly plumose, tawny grey hairs; propodeum with dorso-lateral margins having long fringes of white pile extending halfway down to pedicel, lateral and posterior faces with sparse covering of long, erect, pale grey pile; legs densely covered with short, pale grey pile except posterior femora where it is long, curved, and weakly plumose; first metasomal tergum sparsely covered with long, erect, pale grey pile, weak anterolateral appressed areas, lateral fringes weak, not continuous to fascia; fascia pure white and narrowed medially; metasomal terga two to four with fasciae broad and pure white; discs of metasomal terga five and six with strong admixture of deep ferrugineous to black, erect pile; metasomal sterna nonfasciate.

Antennae short, light reddish-brown, becoming black basally; malar spaces short, approximately three-eighths as long as broad; clypeus weakly protuberant with median longitudinal sulcus not evident, surface coarsely punctate over median discal area, peripheral portions shiny impunctate; vertex shiny impunctate. Prothoracic spines short and sharp; mesoscutum shiny, weakly and shallowly punctate with fine punctures, punctures at least two puncture widths apart on anterior half, impunctate area large; scutellum shiny except for extreme posterior edge which is weakly roughened and finely punctate; metanotum shiny; mesepisterna with upper faces densely and coarsely punctate, punctures becoming

much shallower and more obscure on discal area where they are at least two puncture widths apart; propodeum with lateral and posterior faces very weakly roughened and dull, basal area with a few scattered longitudinal striae, almost indistinguishable; tegulae light brownish hyaline; wings dusky with short, light ochreus pubescence, most evident apically; nervures light brown; stigma dark brown; legs light reddish-brown; posterior basitarsi about four times as long as broad. First metasomal tergum black with bluish tinge, surface shiny except for a few, scattered, folliclelike punctures; metasomal terga two to four shiny and weakly folliculated; metasomal sterna with posterior margins entire.

*Distribution:* Six miles west of Indio, Riverside County, California, April 4, 1949 (Linsley, MacSwain, Smith) on *Melilotus;* Death Valley, Furnace Creek, California, April 14, 1938 (B. E. White) on *Prosopis juliflora glandulosa;* Imperial County, California, April, 1911 (Bridwell) on *Prosopis;* 20 miles west Mexicali, Baja California, April 4, 1939 (E. S. Ross); El Mayor, Baja California, April, 1939 (C. D. Michener) on *Prosopis;* Guaymas, Sonora, Mexico, April 7, 1921 (E. P. Van Duzee); Mesilla Park, New Mexico, May 20 (T. D. A. Cockerell).

The holotype from Mesilla Park, New Mexico, is in the United States National Museum.

### *Colletes clypeonitens* Swenk

(Fig. 77)

*Colletes clypeonitens* Swenk, 1906, Canadian Ent., vol. 38, p. 39; Timberlake, 1951, Wasmann J. Biol., vol. 1, p. 229.

The males of the species are easily distinguished from the rest of the *daleae* group in having the malar spaces twice as long as wide and in having the flagellum of the antennae a light yellow brown below. The yellowishness of the lower surfaces of the antennae may become less pronounced at the eastern extremities of the range where the color changes to light yellow red. The females have the metasomal terga almost completely covered with short appressed pubescence and have very long malar spaces. It may be confused with *petalostemonis* in this group, but differs in size, in having deep ochreus pile on the thoracic terga, and in having the punctures of the mesepisterna shallow to obscure.

*Male:* length 8.5-9 mm., wing length 6 mm.

Pile of face long, loose, and densely clumped about antennal bases and upper edge of clypeus, pile very short and somewhat appressed along lower inner orbital margins; pile of vertex and supra-antennal

areas sparse and slightly tinged with grey; upper genal areas with pale grey pile, becoming longer and whiter below; mesoscutum with long, plumose, white to grey pile; scutellum with abundant, long, fine, plumose pile not obscuring surface, pile of scutellum continuous to metanotum; metapleura with abundant, long, fine, white pile over surface sometimes tinged with grey above; propodeum with lateral and posterior faces with long, fine pile as on mesepisterna; legs with shorter, white to pale grey pile, most densely concentrated on posterior femora and tibiae; first metasomal tergum with scattered, fine, white to pale grey pile not concealing surface, weak lateral fringes continuous to apical fascia, apical fascia narrow and loose; metasomal terga two to five with apical fasciae loose, white, and narrow; discs of metasomal terga two to five with abundant, erect, white to light golden pile; metasomal tergum six with scattered, semiappressed, golden pile; metasomal sterna with broad apical fasciae, hair becoming broader medially and sharply narrowed laterally.

Antennae long, flagellar segments about one and one-half times as long as wide, flagellum strongly tinged with deep yellow below; malar spaces twice as long as wide with weak longitudinal rugae basally; clypeus strongly protuberant with a median sulcus most evident basally, lateral rims of median sulcus shiny and sparsely punctate, punctures deep and dense along median sulcus; vertex closely, finely, and densely punctate. Prothoracic spines virtually absent; mesoscutum shiny with a few, scattered, fine to obscure punctures, closest and most evident at anterolateral edges; scutellum densely and finely punctate over posterior half, not rugose, anterior half impunctate; mesepisterna dull and obscurely punctate or with very fine, shallow punctures; propodeum with lateral and posterior faces dull and roughened, basal area with a few weak longitudinal rugae; tegulae light ochreus hyaline; wings dusky with scattered, light ochreus pile most evident apically, nervures light yellow brown basally, darker brown beyond stigma and first recurrent vein, stigma light brown; legs black; posterior basitarsi five times as long as wide; metasoma shiny black; first metasomal tergum with a few, weak, scattered punctures giving surface a dull roughened appearance; second metasomal tergum dull and weakly folliculated, tergum with no abrupt basal depression; sterna with posterior edges entire; seventh ventral plates with discs roughly triangular with pile most dense at apicolateral and apicomedial margins (fig. 77).

*Female:* length 9.5-10 mm., wing length 6.5 mm.

Pile of face long and fine about antennal bases, becoming much shorter and appressed along lower inner orbital margins, hair about antennal bases long, fine, and tinged with ochreus; pile of ocellar triangle long and bright ochreus; upper genal areas with pile light ochreus becoming lighter to pale grey below, pile immediately posterior to compound eyes short and appressed, tinged with ochreus, posterior and lower faces of genal areas with pile long, fine, and tinged with grey; mesoscutum with abundant, long, plumose, ochreus pile; scutellum with a strong covering of long, ochreus pile about lateral and posterior edges; metanotum with weak covering of light ochreus to grey pile; mesepisterna with abundant, long, fine, pale grey to whitish pile becoming more ochreus at extreme upper surface; lateral and posterior faces of propodeum with abundant, long, pale grey pile; legs with long fine pile, longest on posterior femora which has long, fine, curved, ochreus hairs, especially plumose; metasomal terga covered with short, appressed, ochreus pile on first five terga; first metasomal tergum with shiny nonpubescent area between fascia and basal appressed pubescence, occasionally present on second metasomal tergum; basal appressed pubescence of first metasomal tergum with strong admixture of long, erect pile, appressed pile sparse leaving apical fasciae easily discernible; metasomal tergum six with semiappressed, golden pile; metasomal sterna with weak apical fringes of white pile on sterna two to five.

Antennae light reddish brown, becoming dark brown to black basally; malar spaces one and one-fourth times as long as wide; clypeus abruptly protuberant with a shallow median sulcus, sulcus with a few deep, coarse punctures, lateral rims sparsely punctate with a few deep punctures; vertex dull, finely and densely punctate. Prothoracic spines absent; mesoscutum with abundant, fine, shallow punctures, punctures at least one puncture width apart; scutellum with abundant fine punctures over posterior two thirds; mesepisterna dull, shallowly to obscurely punctate, punctures about two to three puncture widths apart; propodeum with lateral and posterior faces dull and slightly roughened; tegulae light ochreus hyaline; wings with nervures light yellowish brown basally, stigma and apical veins deep brown, wings with apex having sparse covering of ochreus pubescence; legs black; posterior basitarsi long and broad, about four times as long as wide; metasomal terga shiny beneath appressed pubescence, with a few, weak, folliclelike punctures scattered over

discs; metasomal terga two to four weakly folliculated; metasomal sterna entire.

*Distribution:* California: Westmoreland, Imperial County; Edom, Riverside County; Ocotillo, San Diego County; Lone Pine and Panamint Mountains, Inyo County; San Bernardino County; Trona; Stove Pipe Wells. Nevada: Lake Meade; Glendale. Arizona: 5 miles east Yuma; Gila Bend; Welton. Texas: Hot Springs, Big Bend Park.

*Flight records:* March 6 to June 15.

*Plant records: Dalea polyadenia, Larrea tridentata, Prosopis juliflora.*

The holotype from Los Angeles (more probably Palm Springs), California is in the collection of the University of Nebraska.

### *Colletes covilleae* Timberlake

(Fig. 78.)

*Colletes covilleae* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 231.

The males of this species are practically indistinguishable from *salicicola* except on the basis of the seventh ventral plates. Occasionally the second metasomal tergum of *covilleae* has a much smoother disc than does *salicicola;* however this is by no means a salient character. The females are readily distinguished from *salicicola* in having the metasomal terga covered with appressed pubescence and, except for much shorter malar spaces, resemble *petalostemonis* and *clypeonitens.*

*Male:* length 7.5 mm., wing length 6. mm.

Pile of face long and pure white, somewhat appressed along lower inner orbital margins, hair long, fine, and loose, not completely concealing clypeus; ocellar triangle with a few, short, pale grey hairs; upper genal areas with sparse, short, white pile, becoming much longer and whiter below, narrow margins of shorter appressed pubescence immediately posterior to compound eyes; mesoscutum with abundant, long, fine, pale grey pile, not obscuring surface; scutellum with very weak lateral and posterior fringe of pile; metanotum with few, fine, plumose hairs; pronotum with posterior lobe sparingly covered with short white pile; mesepisterna with abundant, plumose, pale grey to white pile; propodeum with dorsolateral edges having weak fringes of long pale grey pile, lateral and posterior faces with sparse, fine, pale grey pile; legs with abundant, long, weakly plumose, white pile; first metasomal tergum with anterior face of disc having moderately dense covering

of long white pile, lateral fringes very weak, apical fascia weak and narrow; metasomal terga three to five with fasciae broad, ragged, and lightly tinged with pale grey; metasomal terga two to five with discs having abundant, fine, short, light ochreus to tawny grey pile giving surface whitish to golden sheen, pile becoming much longer apically; metasomal sterna with broad white apical fasciae, broadest at middle, becoming progressively narrower laterally.

Antennae reddish-brown, flagellar segements about one and three-fourths times as long as broad; malar spaces one and one-half times as long as broad; clypeus strongly protuberant with deep median longitudinal sulcus continuous to apex, median sulcus finely and densely punctate, lateral rims shiny and sparingly punctate with deep coarse punctures, lateral and dorsal clypeal margins finely and densely punctate and roughened; vertex shiny with a few, scattered, weak punctures. Prothoracic spines distinct and sharp; mesoscutum densely punctate over anterior half and lateral margins, punctures one puncture width apart, impunctate area large; scutellum with posterior one third roughened, densely punctate; metanotum shiny and roughened; mesepisterna with shallow obscure punctures leaving surface roughened and dull; propodeum with lateral and posterior faces roughened, basal area with few scattered longitudinal rugae; tegulae light brownish hyaline; wings whitish hyaline with very sparse, light ochreus pubescence at apex, nervures and stigma light brown; legs black basally, tending to brown at apex; posterior basitarsi long and slender, approximately four and one-half times as long as broad. First metasomal tergum shiny and sparsely folliculated; second metasomal tergum shiny with a few, scattered, weak, folliclelike depressions, tergum with sharp basal depression; metasomal sterna with apical margins entire; seventh ventral plate slightly expanded apically with truncate apex, about one and one-fourth times as long as broad (fig. 78).

*Female:* length 9.5 mm., wing length 6.5 mm.

Pile of face sparse, short, tinged with light ochreus, erect about antennal bases and partially appressed along inner orbital margin, a few long pale grey hairs extending from base of clypeus over extreme lateral portions; ocellar triangle with strong clump of deep ochreus pile; upper genal areas with ochreus short pile, becoming longer and whiter on lower and posterior margins, a broad band of light ochreus to pale grey appressed pile immediately posterior to upper two thirds of compound eyes; mesoscutum with pile short, weakly plumose, and deep ochreus, concentrated principally about

anterior half and lateral margins; scutellum with lateral and posterior fringes of long ochreus pile; metanotum densely covered with light ochreus hairs; mesepisterna with dense covering of long pale grey pile; propodeum with dorsolateral margins with long fringes of light ochreus pile, extending one-third of way to pedicel, lateral faces partially concealed by light ochreus, appressed pubescence, posterior face with a few, long, pale grey hairs; legs with long, white to ochreus pile, pile very dense on posterior femora and tibiae; first metasomal tergum with surface partially obscured by light ochreus pubescence, especially at lateral faces of disc, appressed pubescence replaced by long erect pile over median discal surface; metasomal terga two to five with surface having weak covering of short, appressed, ochreus pubescence, not completely concealing surface; fasciae broad and weakly pubescent; sixth metasomal tergum with dense covering of semiappressed golden pile; metasomal sterna lacking fasciae.

Antennae short, deep reddish-brown, flagellum becoming much darker basally; malar spaces about five-eighths as long as wide; clypeus strongly protuberant with deep longitudinal median sulcus extending to apex, lateral impunctate rims with a few, coarse, scattered punctures; vertex shiny with scattered fine punctures. Prothoracic spines vestigial; mesoscutum closely and densely punctate over anterior half and on lateral faces, punctures less than one puncture width apart, impunctate area large and shiny; scutellum with posterior one third densely and finely punctate; metanotum shiny; mesepisterna deeply and densely punctate with punctures about one-half puncture width apart, interspaces shiny; propodeum with lateral and posterior faces shiny and weakly roughened, basal area with few longitudinal striae; tegulae brown hyaline; wings dusky covered with short, light ochreus pubescence most evident apically, nervures and stigma dark brown; legs black, becoming dark brown apically; posterior basitarsi three and one-half times as long as wide. Metasomal terga shiny and weakly folliculated beneath appressed pubescence.

Assuming the sex association to be correct, I am surprised to find this the only species in which the prothoracic spines are sharp and distinct in the male yet absent in the female. It is customary for this condition to be reversed. Otherwise the sexes show close morphological resemblance.

*Distribution:* One male, about 8 miles south of Victorville, Mohave Desert, California, May 22, 1932 (P. H. Timberlake) on *Larrea tridentata;* 1 male, 20 miles south of Palacio, Baja California, April

1939 (C. D. Michener); and 1 female, Andreas Canyon, near Palm Springs, California, April 11, 1936 (P. H. Timberlake) on *Larrea divaricata* (all paratypes).

The holotype from Palm Springs, California, is in the collections of the Citrus Experiment Station, Riverside, California.

### *Colletes salicicola* Cockerell

(Fig. 79)

*Colletes salicicola* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 50; 1897, Bull. New Mexico Agric. Exper. Sta., no. 24, p. 24; 1898, Bull. Denison Univ., vol. 11, p. 43; 1898, Bull. Univ. New Mexico, vol. 1, p. 43; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 292; 1930, Amer. Mus. Nov., no. 397, p. 5; Bohart *et al.*, 1950, Utah Agr. Expt. Sta. Mimeo. Circ. no. 371; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 230.

The species, described from a female taken at Las Cruces, New Mexico, is one of the more common vernal members of the group. Both sexes are most likely to be confused with *daleae*, and in the females the two are distinguished only with difficulty. The males can be separated at once by the form and distinctive hair patterns of the seventh ventral plates. The females are extremely difficult to tell from *daleae* but differ in having the prothoracic spines either vestigial or completely absent. The more easterly populations of *salicicola* occasionally have short vestigial spines but in the western individuals the angle is uniformly rounded. As in the male, the second metasomal tergum is distinctly punctate with somewhat angulate punctures rather than the normally round punctures of the thorax and mesepisterna.

*Male:* length 8 mm., wing length 6 mm.

Pile of face long and white, completely concealing basal portion of clypeus, weak sparse pubescence along lower half of inner orbital margins; vertex with few, scattered, pale grey hairs concentrated principally in the ocellar triangle; upper genal areas with pure white pile, becoming long and much denser over posterior and lower faces; mesoscutum with light ochreus to pale grey pile, partially concealing surface; scutellum with weak lateral and posterior fringes of long, erect, pale grey pile; metanotum with few, scattered, pale grey hairs; mesepisterna with weak covering of very long, fine, ragged, pale grey pile; propodeum with heavy dorsolateral fringes of pile extending halfway down to pedicel, lateral and posterior faces with sparse covering of fine, pale grey pile; legs with abundant, long, white pile; first metasomal tergum with anterior face and disc sparsely covered with ragged, pale grey pile, lateral fringes of white pile longest and most dense at extreme anterolateral edges,

becoming shorter and weaker as fringe nears fascia, apical fascia weak, pale grey, and ragged; metasomal terga two to five with fasciae broad and pure white; metasomal terga two to five with discs having short, fine, erect, white pile, giving surface whitish sheen when viewed laterally; metasomal tergum six with semiappressed, light golden pile; metasomal sterna with broad, dense, white apical fasciae, broadest at mid line.

Antennae long and deep brown, flagellar segments one and three-fourths times as long as broad; malar spaces one and one-half times as long as broad, weakly striate basally; clypeus strongly convex with a deep median longitudinal sulcus, sulcus finely and densely punctate along entire length, lateral rims shiny and sparsely punctate with coarse punctures; vertex shiny with a few, scattered, fine punctures. Prothoracic spines absent; mesoscutum with shallow scattered punctures most dense on anterior and extreme lateral faces where they are no more than one puncture width apart, punctures becoming sparse and much shallower toward posterior and median surfaces of mesoscutum; scutellum shiny and very finely punctate on extreme posterior margin; mesepisterna dull and roughened due to shallow obscure punctures; propodeum with lateral and posterior faces roughened and dull, basal area with abundant close longitudinal weak striae; tegulae light brownish hyaline; wings whitish hyaline to dusky with fine, short, ochreus pubescence on extreme apical portion, nervures light brown, stigma dark brown; legs black; posterior basitarsi weakly rounded above, about five times as long as broad. Metasomal terga shiny black; first metasomal tergum distinctly punctate or coarsely folliculated, surface rough but with black lustre; second metasomal tergum closely and densely punctate or coarsely folliculated, follicles very close and almost contiguous over anterior portion of disc, follicles angulate rather than round; second metasomal tergum with abrupt basal depression; metasomal terga three and four shiny and roughened; metasomal sterna with apical margins entire; seventh ventral plates at least twice as long as broad at base, apex expanded and broadly rounded with dense lateral fringe to each plate, pubescent portion of plates restricted to apical half (fig. 79).

*Female:* length 9 mm., wing length 6 mm.

Pile of face white and slightly tinged with light ochreus above; pile dense along inner orbital margins where it is slightly appressed, pile erect about antennal bases and extending down from dorsolateral edges of clypeus partially concealing lateral edges of clypeus;

vertex with pile light ochreus; upper genal areas with short white pile, becoming longer on lower and posterior surfaces, broad band of appressed white pubescence immediately posterior to compound eyes; mesoscutum with short, dense, ochreus pile particularly over anterior half and lateral edges, impunctate area free of pile; scutellum with weak lateral and posterior fringe of long, light ochreus pile; metanotum with dense covering of plumose, light ochreus hairs; mesepisterna with sparse covering of long plumose hairs, not at all concealing surface; propodeum with strong dorsolateral fringes of long white pile extending down to pedicel, lateral faces concealed partially by short, white, appressed pubescence, posterior face with abundant, long, erect, pale grey pile; anterior two pairs of legs with abundant, long white pile basally, tarsi with strong ochreus pile; posterior femora and tibiae with long, light ochreus pile; first metasomal tergum with anterior face and disc partially concealed laterally by semiappressed white pile, appressed pubescence with strong admixture of long, erect, fine, pale grey hairs, lateral fringes weak, most evident on anterolateral margins, becoming weak at apical fascia, apical fascia tinged with light ochreus and broad; metasomal terga two and three with weak basal fasciae; metasomal terga two to five with discs having short, fine, erect, white pile, giving surface a whitish sheen; sixth metasomal tergum with dense covering of semiappressed golden hairs; sternal fasciae absent.

Antennae with flagellum reddish-brown below and black above; malar spaces about seven-eighths as long as broad; clypeus strongly protuberant, with a distinct, narrow, deep median sulcus extending to apex, sulcus covered with fine dense punctures, lateral rims shiny black with few, coarse, scattered punctures, extreme lateral edges finely and densely punctate; vertex shiny with a few fine punctures. Prothoracic spines virtually absent or vestigial; mesoscutum coarsely punctate over anterior half and lateral edges, punctures no more than one puncture width apart with shiny interspaces, impunctate area large and shiny; scutellum shiny, densely punctate on extreme posterior one third of surface; mesepisterna coarsely and densely punctate on extreme upper surface, puncturation becoming much sparser and shallower on lower surfaces of disc, interspaces broad and shiny, punctures about two puncture widths apart; propodeum with lateral and posterior faces weakly roughened but shiny, basal area with many longitudinal weak striae; tegulae light hyaline brown; wings whitish hyaline with abundant light ochreus pubescence particularly at apex, nervures brown, stigma dark brown to

black; legs deep black basally, strongly tinged with brown at apex; posterior basitarsi approximately four times as long as broad. First metasomal tergum shiny black with a few scattered follicles; second metasomal tergum coarsely folliculated, follicles angulate, not rounded, approximately one to two puncture widths apart on anterior face of disc; metasomal terga three to five weakly and shallowly folliculated.

*Distribution:* Texas: Big Bend National Park. New Mexico: Mesilla; Kerr Ranch. Arizona: Dublin; Sahuarita; Tucson; Yuma; Gila Bend; Palmerlee; Welton; Ajo; Maricopa Mountains; Douglas. Nevada: Lake Meade. California: Palm Springs; Riverside County; Westgard Pass, Inyo Mountains, Inyo County; Lone Pine, Inyo County; Panamint Mountains, Inyo County; Desert Center; Imperial County; San Bernardino County; Trona; Kern County; Twenty-Nine Palms; Dos Palmos, Colorado Desert.

*Flight records:* The species has been recorded as flying between February 17 and June 15 with the main flights occurring during April.

*Plant records: Cercidium, Dalea, Eriogonum, Hyptis, Larrea tridentata* var. *glutinosa, Phacelia popei, Prosopis juliflora* var. *glandulosa.*

The species was based on two females, taken at Las Cruces, New Mexico, on *Salix,* May 2 and 3. Concerning the deposition of the type, Timberlake informs me that he has "the female dated 'May 3' at Riverside. In the description Cockerell makes a Var. *a.*—'posterior triangle of thorax without ridges'. Hence the specimen with ridges on the base of the propodeum must be the type. My specimen has the ridges and hence cannot be Var. *a.* and therefore must be the type, although not so labelled."

### *Colletes deserticola* Timberlake

(Fig. 83)

*Colletes deserticola* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 232.

The males of the species may be confused with *prosopidis* or *algarobiae;* however, they differ from the former in having the lower surface of the flagellum dark brown to black and in having the antennal segments at least one and one-half times as long as wide; in *deserticola* the punctures of the mesepisterna are more distinct. It is more difficult to separate *algarobiae* from *deserticola;* however, *deserticola* has the malar spaces approximately as long as wide and has the clypeus short and closely punctate across the base;

the lower mesepisterna of the male are shallowly and obscurely punctate rather than showing the closer, deeper punctures of *algarobiae*. The seventh ventral plates of *deserticola* are slightly broadened apically and broadly rounded on the extreme apical margins. The females are most easily confused with *daleae* but differ from it in having the malar spaces shorter, slightly more than one-half as long as wide; in having the basal fasciae of metasomal terga two and three broad and dense, and in having the clypeus scarcely sulcate medially.

*Male:* length 9 - 9.5 mm., wing length 6 mm.

Pile of face pure white, long, and dense, concentrated principally about antennal bases and completely concealing clypeus, pile virtually absent above antennal bases; ocellar triangle with a few, long, pale grey hairs; upper genal areas with short white pile, becoming much longer on lower and posterior surfaces, area immediately posterior to compound eyes covered with short appressed pubescence; mesoscutum with long, plumose, pale grey pile, not concealing surface; scutellum with a sparse covering of pale grey pile about lateral and posterior margins, extending over posterior one half of surface; metanotum weakly covered with long, sparse, pale grey pile; mesepisterna and metapleura with sparse covering of long, whitish to pale grey pile; propodeum with dense dorsolateral fringes of long white pile extending from basal area half way to pedicel; legs with short white pile, tending to be loose and ragged; first metasomal tergum with sparse covering of long white pile and very weak lateral fringes not complete to apical fascia; metasomal fasciae narrow, composed of loose, ragged, white pile; metasomal terga four and five with discs having sparse, erect, pale grey to golden pile; metasomal tergum six with weak covering of semiappressed golden pile; sternal fasciae broad and pure white, slightly broader at mid line.

Antennae strongly tinged with light reddish brown beneath, flagellar segments no more than one and one-half times as long as wide; malar spaces about as long as wide; clypeus strongly convex with a shallow median sulcus most evident on basal half, basal area of clypeus and a broad longitudinal median band closely and densely punctate leaving very narrow impunctate ridges, ridges occasionally with a few scattered punctures; vertex shiny with a few, scattered, fine punctures. Prothoracic spines absent; mesoscutum shiny, obscurely punctate to impunctate with a few folliclelike punctures scattered over surface; scutellum smooth and shiny with

a few scattered punctures about lateral and posterior edges; mesepisterna smooth, shiny, and virtually impunctate except for a few, fine, scattered punctures approximately two to four puncture widths apart on disc, punctures distinct and rather deep on extreme upper edge of mesepisterna immediately beneath scrobal area; propodeum with lateral and posterior faces dull, basal area with a few weak longitudinal rugae; tegulae brown; wings tending to whitish hyaline and nonpubescent, nervures light brown, stigma dark brown; legs black basally, tarsi plus apices and bases of tibiae light brown; posterior basitarsi long and slender, approximately four and one-half times as long as wide. Metasoma with basal terga black, strongly tinged with blue giving a metallic lustre to discs; first metasomal tergum shiny and weakly folliculated over surface; second and third metasomal terga with follicles shallower and somewhat closer; second metasomal tergum with basal depression abrupt; metasomal sterna with apical margins entire; seventh ventral plates short and broadened apically, apical lateral and median margins broadly rounded, inner margins of plate slightly reflexed, dense hair bands along inner median margins and a broad longitudinal hair band along lateral margin from below articulation to extreme apex, apex broadly rounded (fig. 83).

*Female:* length 9.5-10.5 mm., wing length 6.5 mm.

Pile of face short, white, and concentrated principally along inner orbital margins where it tends to be somewhat appressed, dense scattering of plumose pile immediately above antennal bases and extending nearly to vertex; fronto-clypeal margin with a few, long, fine hairs extending over surface of clypeus and partially concealing surface; vertex with clump of shorter ochreus pile; upper genal areas with short, light ochreus pile, becoming sparser, longer, and whiter on lower and posterior portions; genal areas with broad, dense, appressed pubescence immediately posterior to compound eyes; mesoscutum with short, dense, plumose, ochreus pile; scutellum with lateral and posterior edges having dense fringe of longer, plumose, ochreus pile not extending forward over anterior half; mesepisterna with sparse, scattered, pale grey pile; propodeum with lateral faces concealed by short, appressed, whitish pile, dorsolateral edges with long, pale grey fringes, posterior face with scattered, erect, pale grey pile; legs with short tawny pile except for posterior femora and tarsi, posterior femora with sparse covering of long, curved plumose hairs; tibiae with pile much shorter, denser, and ochreus, particularly on lateral and lower surfaces; first meta-

somal tergum with scattered pile over disc, becoming somewhat appressed on anterolateral portion of disc, appressed pubescence absent medially, weak lateral fringes, not complete to apical fascia; metasomal terga two and three with very broad basal fasciae, basal fasciae as broad as nonpubescent area between basal and apical fascia of each segment; apical fasciae on metasomal terga two to five broad and pure white; apical fascia of metasomal tergum one strongly narrowed medially; metasomal terga four to six with deep ferrugineous to black, semierect pile over surface; metasomal sternal fasciae absent.

Antennae reddish brown, black basally; malar spaces slightly more than one-half as long as wide; clypeus shiny with a deep median sulcus having a few, deep, coarse punctures along its length, punctures much more sparse on lateral rims; vertex shiny with a few, weak, scattered punctures. Prothoracic spines short and sharp; mesoscutum densely and deeply punctate over anterior one-half and lateral and posterior edges, impunctate area small; scutellum with lateral and posterior margins deeply punctate; mesepisterna deeply and coarsely punctate over entire surface, punctures approximately one puncture width apart, interspaces shiny; basal area of propodeum with a few random rugae; tegulae brownish hyaline; wings with a few, scattered, ochreus hairs, nervures and stigma dark brown; legs black; posterior basitarsi three and one-half to four times as long as broad. First metasomal tergum shiny with few scattered follicles; discs of metasomal terga two and three very shallowly folliculated; metasomal sterna entire.

*Distribution:* California: Furnace Creek, Death Valley; Oasis, Riverside County; Indio, Riverside County; Bard, Imperial County; Kane Springs; San Diego County. New Mexico: Mesilla Park. Baja California: El Mayor.

*Flight records:* March 29 to May 20.

*Plant records: Prosopis juliflora* var. *glandulosa; Melilotus indica.*

Females taken in Riverside County and in Baja California differ markedly from the types in the following respects: the punctation of the mesoscutum is sparse on the posterior half and there is an extremely large impunctate area, the punctures on the anterior half of the mesoscutum are much smaller and not nearly so close, being at least one puncture width apart; the basal hair bands of the second and third metasomal terga are very much narrowed and may be completely hidden on the third; the median sulcus of the clypeus is not nearly so deep as is the typical specimen.

An additional male has been taken at Mesilla Park, New Mexico, which I believe belongs to this species. This specimen probably deserves subspecific rank as the punctures of the mesepisterna are shallow, sparse, and obscure; the apical fascial depressions of the metasoma are extremely broad and very light hyaline; the antennae are tinged with yellow beneath, even more so than in the allotype; the clypeus is more coarsely punctate and the median sulcus is deeper basally than in the typical specimens from Death Valley.

I believe the Riverside and the New Mexican specimens may represent the ends of the known range of the species and that they should probably rank as subspecies. The type locality is somewhat intermediate between the two known peripheral localities.

The holotype from Furnace Creek, Death Valley, California, is in the collection of the Citrus Experiment Station, Riverside, California.

### *Colletes petalostemonis* Swenk

(Fig. 81)

*Colletes petalostemonis* Swenk, 1906, Canadian Ent., vol. 38, p. 40; Timberlake, 1943, Bull. Amer. Mus. Nat. Hist., vol. 81, p. 400; 1951, Wasmann J. Biol., vol. 9, p. 236.

This is the most easterly member of the *daleae* group and is distributed generally along the extreme western edge of the Great Plains, extending as far north as Alberta and south into New Mexico, thence westward to Utah, Arizona and eastern California. The males of the species are distinguished by having the malar spaces at least one and one-half times as long as wide and in having the mesepisterna deeply and coarsely punctate with sharply delineated punctures no more than one puncture width apart with shiny interspaces. In most specimens the discs of the first and second metasomal terga are coarsely and closely punctate. The females are readily distinguished by having the metasomal terga almost completely covered with short, appressed, white pubescence. Usually there is a very narrow, bare, prefascial discal area on metasomal terga one and two; where this non-pubescent area is not present the prefascial area is sparsely covered with pubescence. The malar spaces are at least as long as wide, and the punctures of the mesepisterna are deep and close, separated by shiny interspaces. The pile of the vertex and mesoscutum is pure white to pale grey.

*Male:* length 7.5 mm., wing length 6 mm.

Pile of face long, pure white, and dense about antennal bases and over clypeus, some appressed pubescence along lower inner orbital margins; vertex with pile white; genal areas with short white pile

over upper surfaces becoming longer on lower and posterior faces; mesoscutum with scattered white to pale grey pile; scutellum with longer plumose pile about lateral edges and over posterior one half; mesepisterna with long white pile, not obscuring surface; legs with long, pure white to pale grey pile; first metasomal tergum having anterior face and disc with long, scattered, erect, white pile, lateral fringes with moderately dense, long white pile extending posteriorly to apical fascia, first apical fascia narrow and ragged; apical fasciae of metasomal terga two to five broader and pure white; second metasomal tergum with a weak basal fascia in an abrupt basal depression; discs of metasomal terga two to six with long, scattered, erect, pure white pile, giving surface a whitish tinge; metasomal sterna with apical fasciae broad and pure white medially, becoming abruptly narrowed at lateral edges; sixth metasomal sterna with a light clump of pile at extreme apical face.

Antennae light brown to reddish brown, flagellar segments slightly longer than wide; malar spaces approximately one and five-eighths times as long as wide; clypeus strongly protuberant, having a deep median sulcus most evident basally, sulcus closely and finely punctate, lateral rims of sulcus shiny and sparsely punctate with coarse punctures; vertex shiny, roughened with a few scattered punctures. Prothoracic spines very short and sharp; mesoscutum shiny with scattered shallow or obscure punctures over entire surface; scutellum shiny with close, dense punctures about posterior edge, scutellum with a deep median longitudinal emargination; mesepisterna deeply and coarsely punctate, interspaces shiny, punctures no more than one puncture width apart; propodeum with lateral faces shiny and roughened, posterior lateral margins roughened and broadly rounded, basal area with indistinct quadrate pits and a few weak longitudinal rugae; tegulae light hyaline brown; wings whitish hyaline with short, sparse, scattered pubescence, nervures light yellow basally, stigma and apical veins deep brown to yellow-brown; legs light reddish brown becoming darker basally. First metasomal tergum shiny, deeply punctate with coarse punctures, punctures approximately one to two puncture widths apart at mid line, becoming closer at lateral face; metasomal terga two and three shiny with abundant coarse punctures, no more than one puncture width apart; second metasomal tergum with an abrupt basal depression, depression weakly roughened with obscure punctures; metasomal sterna shiny with apical margins entire; seventh ventral plates with discs as broad as basal condyles, apical margins weakly rounded (fig. 81).

*Female:* length 8.5 mm., wing length 6 mm.

Pile of face pure white, concentrated principally about antennal bases, hair somewhat appressed along inner orbital margins; ocellar triangle with pile white to slightly tinged with grey; upper genal areas with abundant light grey to white pile becoming longer on extreme posterior and ventral margins of occiput, abundant, appressed, pure white pile extending from dorsal to ventral surface behind compound eyes; mesoscutum densely covered with short, plumose, pale grey pile, almost concealing surface; scutellum with long plumose pile about lateral and posterior margins, with posterior one-third of surface covered; metanotum densely covered with shorter, grey, plumose pile; pronotum with lateral surfaces completely concealed with short, pure white, appressed pubescence; mesepisterna with scattered, long, fine pile, not concealing surface; metapleura with short, semiappressed pile not obsuring surface; propodeum with lateral faces covered with short, white, appressed pile, posterior faces with abundant, long, fine pile; anterior two pairs of legs with short, light ochreus to pale grey pile; posterior femora with a long fringe of curved plumose hairs, posterior tibiae with abundant, short, nonplumose, white to pale grey pile; metasoma nearly completely covered with short, pure white, appressed pubescence; first and second metasomal terga with a narrow, nonpubescent prefascial band of variable width; metasomal terga three to five completely covered with appressed pubescence; apical fasciae discernible as a much denser mass of short ragged pubescence; sternal fasciae absent.

Antennae deep reddish brown becoming dark brown basally; malar spaces approximately seven-eighths as long as wide; clypeus abruptly protuberant and shiny with a shallow to obscure longitudinal median sulcus, sulcus evident as linear emargination on basal half, a few, scattered, coarse punctures over surface; vertex shiny, particularly about ocellar triangle, densely punctate above compound eyes. Prothoracic spines virtually absent; mesoscutum closely, coarsely punctate over anterior half and about lateral and posterior edges, impunctate area large and shiny; scutellum with posterior one-third closely punctate, a few scattered punctures extending over anterior two thirds of scutellum; mesepisterna coarsely and densely punctate, punctures approximately one-half puncture width apart, interspaces shiny; propodeum with lateral and posterior surfaces roughened, shiny, basal area with a few longitudinal rugae giving semblance to a few, shallow, linear pits; tegulae light testa-

ceous hyaline; wings whitish hyaline with scattered, light ochreus pubescence, particularly on apical portion, nervures light yellow basally, stigma and apical veins light yellow brown; legs reddish brown, posterior basitarsi about four times as long as wide. First metasomal tergum shiny and coarsely punctate, punctures beneath appressed pubescence approximately one to two puncture widths apart at mid line, becoming slightly more dense toward lateral faces; second and third metasomal terga finely punctate, almost folliculated; second metasomal tergum with weak basal depression; apical fasciae in broad testaceous rims; sterna with apical margins entire.

*Distribution:* Alberta: Medicine Hat; Manyberries. North Dakota: Beade. South Dakota: Hot Springs. Nebraska: Munroe Canyon, Glen Sioux County. Wyoming: Lusk; Sheridan; Wheatland. Colorado: Boulder; Larimer County. Utah: Rainbow Bridge. New Mexico: Jemez Springs; Albuquerque; Isleta. Arizona: Holbrook. California: Lone Pine, Inyo County.

*Flight records:* June 25 to August 27.

*Plant records: Melilotus alba, Petalostemon flavescens, Dalea polyadenia.*

The holotype from War Bonnet Canyon, Nebraska, is in the collections of the University of Nebraska.

### *Colletes prosopidis* Cockerell

(Fig. 82)

*Colletes prosopidis* Cockerell, 1897, Ann. Mag. Nat. Hist., ser. 6, vol. 19, p. 46; 1898, Bull. Denison Univ., vol. 11, p. 42; 1898, Bull. Univ. New Mexico, vol. 1, p. 42; 1899, Catalogo de las Abéjas de México, Secretaría de Fomento, p. 4; 1906, Trans. Amer. Ent. Soc. vol. 32, p. 292; Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 235.

The species is the smallest of the *daleae* group and is readily distinguishable by its small size and by the color of the flagellum which is very light yellow beneath. The male has short malar spaces, approximately as long as wide; the punctation over the entire body is shallow and almost obscure. The female has the flagellar coloration and the punctation as in the male.

*Male:* length 6.5 mm., wing length 4.5 mm.

Pile of face pure white and long, concealing most of clypeus, pile along inner orbital margin somewhat appressed; vertex with little white to pale grey pile; upper genal area with a few, short, white hairs, becoming much longer below, a weak margin of appressed pubescence posterior to compound eyes; mesoscutum with sparse covering of fine, white to pale grey pile; scutellum with dense lateral

and posterior fringe of long white pile, somewhat plumose; metanotum with a few, scattered, white hairs; posterior lobes of pronotum with dense clump of long white pile; mesepisterna and metapleura with scattered, long, fine pile not at all concealing surface; propodeum with weak laterodorsal fringes of pale grey pile, lateral and posterior faces with scattered pile; legs with very little pile, having a few white to grey hairs on femora and tibiae; first metasomal tergum with anterior face and disc with a few white hairs, rather dense lateral fringes extending to apical fascia, apical fascia narrow and pure white; discs of metasomal terga two to five with fine, short, white, erect pile, giving surface whitish sheen when viewed laterally; metasomal sterna with weak apical fasciae most evident laterally, pile absent on mid-line except of metasomal sternum two where it is broad.

Antennae light yellowish red, much more yellow beneath, flagellar segments about one and one-third times as long as wide; malar spaces about as long as broad; clypeus not strongly protuberant, median sulcus very shallow and almost indistinguishable except at base, basal half closely and densely punctate, punctures extending down median weakly sulcate portion to apex, very small lateral impunctate areas; vertex shiny with a few shallow punctures. Prothoracic spines short and sharp; mesoscutum virtually impunctate, shiny except for a few folliclelike punctures, especially at extreme lateral and anterior faces; scutellum shiny impunctate except on extreme lateral and posterior edges; mesepisterna shiny and virtually impunctate; propodeum with lateral and posterior faces roughened and dull, basal area with few to no weak rugae; tegulae deep brownish hyaline; wings whitish hyaline with nervures and stigma light brown, becoming much more yellow basally; legs deep reddish brown; tarsi lighter brown; posterior basitarsi long and slender, approximately four times as long as broad. First metasomal tergum shiny black with a distinct bluish lustre, a few weak punctures over disc; second metasomal tergum obscurely punctate with close, shallow obscure follicles, tergum with abrupt basal depression; metasomal terga three to five shiny and weakly roughened; sterna entire; seventh ventral plate quadrate with extreme apical margin sloping basally towards median edge; dense fringes of pile along lateral and basal median edge of plates (fig. 82).

*Female:* length 7.5 mm., wing length 5.5 mm.

Pile of face white, short, and erect about antennal bases, becoming more dense and partially appressed along lower three fourths of

inner orbital margins; vertex with little pale grey pile in ocellar triangle; upper genal areas with pile short and white, becoming sparser on posterior and lower portions, a broad band of appressed white pubescence immediately posterior to compound eyes; mesoscutum with very few, scattered, pale grey hairs; scutellum with a rim of pale grey pile about lateral and posterior edges, not at all obscuring surface; metanotum with a few, scattered, pale grey hairs; mesepisterna with a few, sparse, fine hairs; posterior lobes of pronotum with a dense white covering of short, plumose, erect pile; propodeum with strong dorsolateral fringes of white pile extending halfway down to pedicel, lateral and posterior faces covered with rather short, semi-appressed hairs; anterior two pairs of legs with sparse covering of pile, apices of tibiae with dense clump of white to pale grey pile on upper surface, posterior femora with a few, long, curved, plumose hairs, posterior tibiae having lateral and ventral surfaces closely pilose; first metasomal tergum having anterior face of disc with a few, scattered, fine hairs, disc virtually free of any pilosity, very weak lateral fringe on extreme anterolateral margin; fascia pure white and narrow; disc of metasomal tergum five with a deep golden, semierect pile; metasomal tergum six with deep ferrugineous to deep golden, semiappressed pile; sternal fascia absent.

Antennae short, strongly tinged with yellow beneath, base deep brown to black; malar spaces three-eighths as long as wide; clypeus strongly convex, median sulcus almost completely indistinguishable, shiny with a few coarse punctures especially along median line, surface shiny with a few scattered punctures over lateral ridges; vertex shiny especially about ocellar triangle, a few fine punctures above compound eyes. Prothoracic spines short and sharp; mesoscutum shiny, obscurely punctate to impunctate except for a few folliclelike punctures about anterior and lateral edges, very large shiny impunctate area; scutellum shiny, black, with fine dense punctures about posterior edge; mesepisterna shiny, shallowly to obscurely punctate, punctures scattered, at least two to four puncture widths apart; propodeum with anterior portion of lateral faces shiny, becoming roughened over posterior portion of lateral face and posterior face of propodeum, basal area smooth, non-rugose; tegulae deep brown hyaline; wings dusky to whitish with short ochreus pubescence at apex, nervures and stigma deep brown; legs deep brown to black, posterior basitarsi three and one-half times as long as wide. Metasoma with discs black, tinged with deep blue, giving metallic lustre to surface of terga one and two; metasomal

terga one to three shiny and somewhat folliculated, follicles sparse and shallow, at least two follicle widths apart at mid line; discs of metasomal terga two to five shiny and weakly roughened; metasomal sterna entire.

*Distribution:* California: Palo Verde, Imperial County; Indio, Riverside County; Oasis, Riverside County; Furnace Creek, Death Valley, Inyo County; Kane Springs. New Mexico: Mesilla Park; Las Cruces. Texas: Hot Springs, Big Bend Park.

*Flight records:* March 29 to May 12.

*Plant records: Melilotus indica, Prosopis juliflora.*

The species appears to have a similar distribution to that exhibited by many other members of this group, being found in the deserts of California, New Mexico, and western Texas. It has not as yet been collected in Arizona but I attribute this to incomplete collections.

The type of *prosopidis,* a male from Las Cruces, New Mexico, was last recorded in the Cockerell collection. Efforts to locate this specimen have been unsuccessful.

### *Colletes solitarius* Timberlake

*Colletes solitarius* Timberlake, 1951, Wasmann J. Biol., vol. 9, p. 216.

In the introduction to the original description of this species Timberlake states that it is a probable member of the *hyalinus* group and resembles *C. lutzi* and *C. phaceliae* closely. This contention is apparently based on the punctation of the clypeus and the supraclypeal area, which are closely punctate, some of the punctures tending to be striate. While the clypeal puncturation of this species is not typical of other members in the *daleae* group, it represents only one nonconforming feature among the many other salient characteristics of that group. The antennae are short and strongly tinged with yellowish or very light brown below; the malar spaces are long, much longer than any members of the *hyalinus* group, being approximately one-half as long as broad; the prothoracic spines are very short, almost vestigial; the propodeum has the basal area sloping ventrally and very obscurely pitted, the pits barely distinguishable, the lateral and the posterior faces shiny, smooth, and distinctly punctate with punctures two to four puncture widths apart; the wings tend to whitish hyaline; the metasomal terga have the apical margins light brownish to almost yellow hyaline; and the first metasomal tergum is shiny, very finely and sparsely punctate. On the basis of the aforementioned characters I consider this species to be a member of the *daleae* group.

*Female:* length 9 mm., wing length 6.75 mm.

Pile of face long, rather dense, and white about antennal bases and along inner orbital margins, a few, long, white hairs overhanging basal area of clypeus; vertex with pile pale grey to dusky, concentrated principally in ocellar triangle; upper genal areas with pile pale grey, becoming longer, finer, and pure white below, a broad band of appressed white pubescence immediately posterior to each compound eye; mesoscutum with pile dusky, sparse, and most dense over anterior and lateral margins; scutellum with a narrow lateral and posterior fringe of dusky pile; mesepisterna with pile long, fine, and white; propodeum with dense fringes of long, whitish pile on lateroposterior margins, fringes most dense and longest above, becoming shorter and sparser below, lateral and posterior faces with a sparse covering of whitish pile, tending to become semiappressed on lateral faces; legs with pile sparse, long, and white, tinged with light yellow on posterior femora and tibiae; first metasomal tergum with apical fascia weak and whitish, apical portion of segment easily visible through sparse covering, especially medially, lateral fringes of white pile extending to apical fascia, disc with abundant, erect, whitish pile, particularly on extreme anterior face; metasomal terga two to four with fasciae broad, weak, and white, tending to be broadened medially and on extreme lateral faces; second metasomal tergum with a weak yet broad basal fascia of white pubescence; metasomal terga three and four with basal fasciae weak and much broader than that of second tergum, partially obscuring entire discal area of tergum four; metasomal terga four to six with pile of discal areas intermixed with erect, long, pale grey to light fuscous hairs; metasomal sterna with a few, longer, pale grey hairs on extreme apical portion.

Antennae short, yellowish brown below to becoming deep brown to black above, flagellar segments three-fourths as long as broad; malar spaces one-half as long as broad; clypeus weakly convex, rather densely punctate over basal three fourths, punctures one-half to one and one-half puncture widths apart, separated by shiny interspaces, punctures for most part round, tending to be very slightly striated, particularly laterally; vertex shiny, sparsely punctate; fascial foveae very narrow, obscure, not extending above inner orbital margins. Prothoracic spines short, vestigial; mesoscutum densely punctate over anterior one half and lateral margins, punctures one-half to one puncture width apart, impunctate area large; mesoscutum rather densely punctate about extreme lateral and posterior margins, punctures not at all roughened but with shiny, linear inter-

spaces, disc shiny, sparsely punctate on posterior half, punctures one to three puncture widths apart, anterior one-half shiny, impunctate; mesepisterna deeply punctate, punctures one-half to one puncture width apart, being more dense above, interspaces shiny; propodeum with basal area weakly sloping ventrally, shallowly and irregularly pitted with pits tending to become elongate and obscure medially, lateral and posterior faces shiny and sharply punctate, punctures one to three puncture widths apart; tegulae light brownish hyaline; wings sparsely covered with light fuscous pile, nervures light brown; legs deep brown to black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, very finely and sparsely punctate, punctures almost folliculated, three to four puncture widths apart; second metasomal tergum shiny, finely, irregularly folliculated, follicles much more dense than on first metasomal tergum; metasomal terga one to five with fascial depressions light yellow brown; metasomal sterna shiny, rather coarsely and sparsely folliculated, particularly on apical portions of each sternum.

*Distribution:* Lone Pine, Inyo County, California, May 23, 1937 (E. C. Van Dyke) (holotype).

The holotype is in the collection of the California Academy of Sciences.

The holotype has the pubescence of the metasomal terga rather matted, probably due to moistening, and the exact pubescent covering is difficult to discern.

### GROUP XVII—*aridus*

### *Colletes aridus* sp. nov.

(Fig. 75)

This species resembles *scopiventer* Swenk most closely, but I have no males of *scopiventer* with which to make further comparisons. The males have short malar spaces, one-third as long as wide, no dark pile on the body, an impunctate first tergum, and white sternal fasciae. The females differ from *scopiventer* in having no dark pile on the thoracic dorsum, shorter prothoracic spines, and much narrower fascial foveae, particularly dorsally.

*Male:* length 7.5 mm., wing length 6 mm.

Pile of face dense about antennal bases, supra-clypeal area, and along inner orbital margins, being rather sparse over clypeus; vertex with sparse, fine, pale grey pile; upper genal areas with pile long, fine, and white to pale grey, becoming much longer and

whiter below; mesoscutum with pile very long, ragged, and tinged with light ochreus, a few darker hairs, not black, intermixed on median discal area; scutellum with pile very long and tinged with light ochreus, a few darker hairs intermixed; mesepisterna with pile long, fine, and white; propodeum with dense fringes of long pile tinged with ochreus at dorsal lateroposterior margins, lateral and posterior face with abundant, long, fine, pale grey pile; pile of legs short, sparse, and pale grey; first metasomal tergum with a weak fringe rather than a fascia of white pile along apical margin, often interrupted medially, lateral fringes of white pile not complete or weakly complete to apical fascia, fringes very weak, disc with sparse, erect, whitish pile; metasomal terga two to five with fasciae narrow, dense, and white; metasomal terga three to six with discs having abundant, erect, light fulvous to whitish pile; metasomal sterna with apical margins having fringes of short, light ochreus pile.

Antennae short, deep brown to black, flagellar segments approximately as long as wide; malar spaces one-third as long as broad; clypeus very weakly convex and short with surface rather closely and densely punctate over basal one half, punctures becoming sparser, more striate, and slightly coarser apically; vertex dull, rather closely punctate. Prothoracic spines very short and sharp; mesoscutum finely and densely punctate over anterior one-third and extreme lateral margins, impunctate area very large, extending well up to median line of the mesoscutum; scutellum sparingly punctate, almost impunctate, a few, scattered, coarse punctures on discal area; mesepisterna rather densely punctate and dull above, punctures no more than one puncture width apart, becoming finer and much sparser, with broad shiny interspaces below, punctures one to two puncture widths apart; propodeum with basal area sloping sharply ventrally, basal area with longitudinal, shallow, quadrate pits, lateral and posterior faces dull and roughened; tegulae deep hyaline brown; wings dusky with rather sparse, fulvous pubescence, nervures brown; legs black; posterior basitarsi three and three-fourths times as long as broad. First metasomal tergum shiny, black tinged with a metallic blue lustre, very sparsely punctate or coarsely folliculated, with punctures two to six puncture widths apart; second metasomal tergum shiny, tinged with a metallic blue lustre but with punctures a little more close than on the first tergum, the tergum with a sharp basal depression; metasomal sterna dull, very densely and finely folliculated; seventh ventral plates distinctive, almost linear in their lateral expansion, with median directed processes (fig. 75).

*Female:* length 8.5 mm., wing length 6.25 mm.

Pile of face short and rather dense about antennal bases and particularly along lower inner orbital margins; vertex with abundant, pale grey pile; upper genal areas with pile dense, short, and pale grey, becoming finer, longer, and whiter below, with a weak margin of appressed, white pubescence immediately posterior to compound eyes; mesoscutum with pile short, dense, and clumped principally on anterior and lateral margins, pile with no black hairs intermixed; scutellum with pile tinged with grey to ochreus about extreme lateral and posterior margins; mesepisterna with pile long, fine, dense, and white; propodeum with dense fringes of long, pale grey pile on lateroposterior margins extending from upper surface down to pedicel, posterior face with abundant, long, fine, pale grey pile; legs with pile rather short and sparse on first two pairs, becoming long, plumose, and tinged with yellowish to pale grey on posterior femora and tibiae; first metasomal tergum with a narrow, dense, white apical fascia, narrowed medially, lateral fringes of pile short and weak, barely extending to apical fascia, disc with sparse, short, pale grey pile; metasomal terga two to five with fasciae very broad, white, and dense; metasomal terga three to five with discs having abundant, erect, light fulvous to pale grey pile, not concealing surface; metasomal sterna two to five with abundant, erect, light ochreus pile, forming a strong scopa.

Antennae deep brown, flagellar segments one-half as long as broad; malar spaces short, one-eighth as long as broad; clypeus weakly convex, rather sparsely punctate with shiny interspaces, punctures one-half to two puncture widths apart over surface, tending to lie in longitudinal rows, especially laterally; vertex shiny with a few fine punctures; fascial foveae deep, broadened medially and narrowed abruptly above, extending less than one-third of way from compound eyes to lateral ocelli. Prothoracic spines very short and sharp; mesoscutum rather densely and finely punctate on anterior one third and about extreme lateral margins, impunctate area very large; scutellum shiny, discal area very sparsely punctate with a few coarse punctures; mesepisterna finely and densely punctate, punctures no more than one puncture width apart, interspaces shiny; propodeum with basal area obscurely quadrately pitted with elongate quadrate pits, sloping sharply ventrally, lateral and posterior faces dull and roughened; tegulae brownish hyaline; wings dusky with abundant fulvous pubescence, especially apically, nervures dark brown; legs black; posterior basitarsi three times as long as broad. First metasomal tergum shiny, virtually impunctate

except for a few, sparse, scattered follicles; second metasomal tergum much as first, with a little more dullish cast, very sparsely and finely folliculated; metasomal sterna dull, very densely and finely folliculated, last metasomal sternum with apical one third sharply depressed and free of pile.

*Distribution:* Holotype male, allotype female and one female paratype, Comstock, Texas, April 13, 1949 (Michener, Beamer) on *Phacelia popei;* additional paratypes: 6 males, McCamey, Texas, April 10, 1949 (Michener, Beamer); one male, Langtry, Texas, March 27, 1946 (C. D. Michener); one male, one female, Milagro, New Mexico, June 23, 1941 (L. H. Banker); one female, Vaughn, New Mexico, June 17, 1940 (T. B. Mitchell).

The holotype and allotype are in the Snow Entomological Collections of the University of Kansas.

## GROUP XVIII—*titusensis*

### *Colletes titusensis* Mitchell

(Fig. 84)

*Colletes titusensis* Mitchell, 1951, J. Elisha Mitchell Sci. Soc., vol. 67, p. 237.

This species was described by Mitchell from a single male taken at Titusville, Florida. The present paper includes a description of a female taken at Tampa and designated as the neallotype. The species is believed to lie near the *consors* group on the basis of the short antennae in both sexes, and the apical depression of the last sternum of the female. This is a tentative placement because many of the characteristics are not typical of the *consors* group. The penis valves have no dorsal wings. The eyes are very large and the mesepisterna rugosely punctate; the clypeus is short and densely and coarsely punctate; and the first metasomal tergum is shiny and weakly folliculated. The malar spaces are approximately one-eighth as long as broad in the male and linear in the female.

*Male:* length 8.5 mm., wing length 6 mm.

(Pile of specimen is matted and much has been removed, making a description of the amount of pile and its color difficult.) Face with sparse, erect, light ochreus pile, appearing to conceal clypeus; vertex with a few, pale grey hairs, particularly in ocellar triangle; upper genal areas with pile long, fine, and pale grey, becoming slightly longer yet sparse and much whiter below; pile of mesoscutum sparse, fine, and pale grey on anterior one-half; appearance of a few darker hairs on discal area of scutellum (but difficult to discern because of the condition of the specimen), a fringe of pale grey

pile about peripheral margin of scutellum; mesepisterna with sparse, long, fine, pale grey pile; propodeum with weak fringes of pale grey pile on posterolateral margins, posterior and lateral faces with sparse, fine, erect, white hairs; pile of legs sparse, fine, and pale grey; metasomal terga with fasciae absent but evidence of weak fasciae on lateral margins of terga two to five; metasomal sterna with weak apical fringes of whitish pile, fringes apparently interrupted medially.

Antennae deep brown to black, short, flagellar segments as long as broad; malar spaces one-eighth as long as broad; clypeus weakly convex, very densely and finely punctate over entire surface, punctures not rugose or striate; vertex shiny, sparsely punctate, compound eyes extremely large. Prothoracic spines short and sharp, shorter than width across base; mesoscutum densely punctate with punctures less than one puncture width apart over anterior two-thirds, impunctate area absent; scutellum densely punctate over posterior one-half, punctures sparse medially and absent on anterior margin; mesepisterna coarsely, contiguously punctate; metapleura with weak processes above, similar to that in *americanus* group, and very narrow, indistinct, black rims; propodeum with basal area narrow and deeply quadrately pitted, lateral faces dull, roughened and weakly rugose near lateroposterior margins, posterior face with many coarse rugae or striae, forming weak longitudinal pits over the surface; tegulae deep brown; wings dusky, very densely covered with fulvous pubescence, nervures brown; legs black; posterior basitarsi three and one-half times as long as broad. First metasomal tergum shiny, very finely punctate, punctures folliclelike, much denser and finer on apical one third, punctures one to four puncture widths apart on median discal area; metasomal tergum two shiny and sparsely folliculated; metasomal sterna shiny and very finely roughened; seventh ventral plates roughly quadrate with apical ends divergent, weakly plumose over apical one-third, the plates weakly hyaline; capsule of penis valves lacking dorsal convolutions, lateral portion of the volsellae much longer than medial rounded portion (fig. 84).

*Female:* length 9 mm., wing length 6.5 mm.

Pile of face short, erect, and white; scattered white pile over clypeus; pile of vertex pale grey; upper genal areas with pile pale grey, becoming longer and whiter below, a weak fringe of appressed pubescence behind each compound eye; pile of mesoscutum short and white over anterior and lateral margins, strong admixture of

black pile on median discal area; scutellum with a lateral fringe of pale grey to light ochreus pile, discal area with abundant, erect, black pile; mesepisterna with pile long, fine, and white; propodeum with dense fringes of pale grey pile on the upper lateroposterior margins, lateral face with pile pale grey, erect, and sparse; pile of legs dense, long, white to pale grey; first metasomal tergum with a narrow apical fascia of white pile, very weak lateral fringes of pale grey pile extending to apical fascia, anterior face of disc with a few, erect, short hairs; metasomal terga two to five with weak fasciae of short white pubescence, discal areas with pile fulvous to pale grey; metasomal sterna with abundant, erect, discal pubescence forming a weak scopa.

Antennae brownish black, flagellar segments one-half as long as broad; malar spaces linear; clypeus weakly convex, very densely punctate over entire surface, punctures not striate or rugose; vertex shiny, sparsely punctate with shiny interspaces; fascial foveae narrow, broadened slightly medially, deep and impunctate. Prothoracic spines very short, slightly shorter than width across base; mesoscutum coarsely punctate, punctures approximately one-half to one puncture width apart about anterior half and lateral margins, impunctate area small; scutellum with punctures of discal area coarse, approximately one puncture width apart, becoming sparser and finer anteriorly; mesepisterna finely, densely, contiguously punctate, dull; metapleura with weak dorsal protuberances similar to those of the *americanus* group, with very narrow, light rims (this can be seen only with difficulty); propodeum with basal area deeply quadrately pitted, lateral faces dull and roughened, posterior face weakly roughened and dull; tegulae deep brown; wings dusky, densely covered with fulvous pubescence, nervures brown; legs deep brown to black; posterior basitarsi four times as long as broad. Metasomal terga one and two shiny, sparsely folliculated; metasomal sterna dull, rather densely and finely folliculated over the posterior three fourths of each tergum, extreme apical margins of metasomal terga one to five with a light hyaline rim; last metasomal tergum with apical one half depressed, shiny, and non-pubescent with an apical fringe of long, fulvous pile.

*Distribution:* Florida: Titusville, April 25, 1923 (holotype); Tampa (neallotype).

The holotype is in the American Museum of Natural History. The neallotype is in the United States National Museum.

## GROUP XIX—*longifacies*

### *Colletes longifacies* sp. nov.

The position of this species, based on two females, one complete, the other lacking an abdomen, is uncertain. The head and thorax resemble those of *latitarsis*, while in other features it closely resembles the *productus* group. The female can be readily distinguished from the closest species in having the malar spaces three-fourths as long as broad; the clypeus very long and flattened with a very sharp, longitudinal median sulcus; and the first metasomal tergum shiny, impunctate. There is a strong admixture of black or dark pile on the vertex, mesoscutum, and scutellum. The posterior basitarsi are long and slender, not as in the *latitarsis* group.

*Female:* length 10.5 mm., wing length 6.75 mm.

Pile of face erect and white to pale grey about antennal bases and along inner orbital margins, pile tending to become somewhat appressed along lower inner orbital margins; pile of vertex tinged with ochreus and intermixed with a few dark and black hairs; upper genal areas with pile long, fine, and pale grey, becoming much longer, finer, and whiter below, a very weak rim of short, appressed, white pubescence immediately posterior to each compound eye; mesoscutum with pile pale grey to dusky, concentrated principally on anterior one half and lateral margins, disc with a strong admixture of dark and black hairs; scutellum with a lateral and posterior fringe of dusky, dark, and black pile, black predominating toward median discal area; mesepisterna with pile long, fine, and pale grey to white; propodeum with long fringes of pale grey pile along lateroposterior margins, pile long and dense on dorsal surfaces; pile of legs short on anterior two pairs to long, plumose, and tinged with ochreus on posterior legs, posterior tibiae with a strong admixture of deep ochreus to black pile on upper surface; first metasomal tergum with apical fascia broad and white, interrupted medially, lateral fringes of white pile barely reaching apical fascia, disc with extreme anterior face having abundant, erect, white pile; metasomal terga two to four with fasciae broad, dense, and white; second metasomal tergum with a distinct, white, basal fascia; metasomal terga three to five with discs having a very weak covering of short, light pile; metasomal sterna two to four with apical fringes of tawny pile often interrupted medially.

Antennae reddish brown, flagellar segments just barely longer than broad; malar spaces three-fourths as long as broad; clypeus long and flattened, with a sharp longitudinal median sulcus ex-

tending from base to apex, the surface dull and very sparsely, shallowly punctate, punctures most dense about frontoclypeal margins and along median depressed area, punctures one to three puncture widths apart, being very sparse on apical and lateroapical margins; vertex finely and rather densely punctate with shiny interspaces; fascial foveae deep and broadly triangular, dorsal margin pointed, just barely reaching above inner orbital margins. Prothoracic spines stout and sharp, approximately one and one-half times as long as width across base; mesoscutum densely punctate about anterior one-half and extreme lateral margins, punctures one-half to one puncture width apart, impunctate area small, scutellum densely, contiguously punctate about lateral and posterior edges, punctures becoming more distinct on median discal area where they are no more than one-half puncture width apart, extreme anterior margin shiny, impunctate; mesepisterna densely and coarsely punctate, punctures almost contiguous above to one-half puncture width apart below, punctures tending to become somewhat obscure on lower and posterior margins; propodeum with basal area broad, shallowly, quadrately pitted, lateral and posterior faces shiny and very finely roughened; tegulae brownish hyaline; wings dusky with abundant fulvous pubescence, nervures brown; legs brown to reddish brown; posterior basitarsi four and one-fourth times as long as broad. First metasomal tergum shiny, impunctate, very finely and sparsely folliculated on lateral margins; second metasomal tergum finely and rather densely folliculated; metasomal sterna shiny, finely and densely folliculated on apical half of sterna two to four.

Holotype, female, and one female paratype: De Funiak Springs, Florida, October 17-19, 1914, paratype with the abdomen missing.

The holotype is in the American Museum of Natural History.

## ADDENDA

### *Colletes nitidus* Smith

*Colletes nitidus* Smith, 1879, Desc. new species Hymenoptera in the British Mus., p. 1; Viereck, 1902, Canadian Ent., vol. 34, p. 330; 1903, Ent. News, vol. 14, p. 120; Cockerell, 1904, Ent. News, vol. 15, p. 276; Swenk, 1908, Univ. Nebraska Studies, vol. 8, p. 36.

I. H. H. Yarrow of the British Museum endeavored to locate the type of this species for comparison but was unable to do so. An examination of the type will be necessary to clarify its status. As discussed elsewhere in this paper, it may well prove to be the same as *carolinus* Mitchell.

"(Female: length 5 lines—Black; the pubescence white; that on the thorax above slightly tinged with yellow; the abdomen very bright, smooth and shining. The clypeus strongly punctured; the flagellum of the antennae fulvous beneath towards the apex. Thorax shiny and punctured; wings hyaline and iridescent, the nervures fusc-ferruginous. Abdomen impunctate at the base and very finely punctured towards the apex; the apical margin of each segment, except the basal one, with a white pubescent fascia.

"Male: A little smaller than the female, of the same jet-black colour, with similar white pubescence, and the same bright polished abdomen; the latter is oblong-ovate in the male, and of conical shape in the female, the apex being pointed. Hab. East Florida.)"

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## REFERENCES CITED

ARNOLD, G.

1947. A key to the African genera of the Apidae, Jour. Ent. Soc. South Africa, vol. 11, pp. 193-218.

BISCHOFF, H.

1930. Beitrag zur Kenntnis paläarktischen Arten der Gattung Epeolus, Deutsche Entom. Zeitschr., pp. 324-331.

BLAIR, K. G.

1920. Bombylius minor L. and some other parasites or inquilines of Colletes daviesana Sm., Ent. Monthly Mag., vol. 56, pp. 200-202.

CLAUDE-JOSEPH, F.

1926. Recherches biologiques sur les Hyménoptères du Chili (Mellifères), Ann. Sci. Nat. (Zool.) [Paris)], ser. 10, vol. 9, pp. 113-268, 78 figs.

CRAMPTON, G. C.

1919. The genitalia and terminal abdominal structures of the males, and the terminal abdominal structures of the larvae of "Chalastogastrous" Hymenoptera. Proc. Ent. Soc. Washington, vol. 21, pp. 129-148.

1920. A comparison of the genitalia of male Hymenoptera, Mecoptera, Neuroptera, Diptera, Trichoptera, Lepidoptera, Homoptera and Strepsiptera, with those of lower insects. Psyche, vol. 27, pp. 34-45.

1920(a). Remarks on the basic plan of the terminal abdominal structures of the males of winged insects. Canadian Ent., vol. 52, pp. 178-183.

1938. The structures called parameres in male insects. Bull. Brooklyn Ent. Soc., vol. 33, pp. 16-24.

CRESSON, E. T.

1887. Synopsis of the families and genera of the Hymenoptera of America, north of Mexico. Trans. American Ent. Soc. (suppl.), vi + 351 pp.

CROSSKEY, R. W.
1951. The morphology, taxonomy, and biology of the British Evanioidea (Hymenoptera). Trans. R. Ent. Soc. London, vol. 102, pp. 247-301.

DALLA TORRE, C. G. DE
1896. Catalogus hymenopterorum, vol. 10. Leipzig, viii + 643 pp.

D'ROZARIO, A. M.
1942. On the development and homologies of the genitalia and their ducts in Hymenoptera. Trans. R. Ent. Soc., vol. 92(2), pp. 363-415.

ELSE, F. L.
1934. The developmental anatomy of the male genitalia in Melanoplus differentialis (Locustidae, Acrididae, Orthoptera). Jour. Morph., vol. 55, pp. 577-609.

FRIESE, H.
1910. Zur Bienenfauna des südlichen Argentienen. Zool. Jahrb., Abt. Syst., vol. 29, pp. 641-660.
1912. Die Siedenbienen (Colletes) von Zentraleuropa. Arch. Naturg. 78 Jhrg. 1912 Abt. A. S., pp. 149-161.
1921. Nachtrag zur Bienenfauna von Costa Rica. Stettiner Ent. Ztg., vol. 82, p. 83.
1922. Die europaischen Bienen: das Leben und Wirken unserer Blumenwespen. vii + 456 pp., pls. 1-33.

GRIFFIN, F. J.
1935. *In* Richards, Notes on the nomenclature of the Aculeata Hymenoptera. Trans. R. Ent. Soc. London, vol. 83, p. 174.
1938. On the date of publication of Latreille (in Sonnini's Buffon). An X [*sic*], Hist. nat. gén. partic. Crust. Ins. 3, J. Soc. Bibliography Natural Hist., vol. 1, p. 157.
1938(a). The date of publication of Kirby's "Monographia Apum Angliae" 2 vols. 1802. J. Soc. Bibliography Natural Hist., vol. 1, p. 158.

JOHANNSEN, O. A., and F. H. BUTT
1941. Embryology of insects and myriapods. McGraw-Hill Book Co., New York City. xi + 462 pp.

LATREILLE, P. A.
1802. Histoire naturelle des fourmis. 8 + 445 pp.
1802. Histoire naturelle générale et particulaire des crustacés et des insectes. vol. 3, 467 pp.

MALYSHEV, S. I.
1923. La nidification des Colletes Latr. Rev. Russe Entom. T., vol. 18, pp. 103-124.
1927. Lebensgeschichte des Colletes cunicularius L. Zeitschr. Morph. Oekol. Tiere. 9 Abt. A. pp. 390-409.

MAYET, VALÉRY
1875. Mémoire sur les moeurs et les métamorphoses d'une nouvelle espèce de Coleoptère de la famille des vésicants le Sitaris colletis. Ann. de la Soc. Ent. de France, ser. 5, vol. 4, pp. 65-94.

MICHENER, C. D.
1944. Comparative external morphology, phylogeny, and a classification of the bees (Hymenoptera). Bull. American Mus. Nat. Hist., vol. 82, pp. 157-326.
1944(a). A comparative study of the appendages of the eighth and ninth abdominal segments of insects. Ann. Ent. Soc. America, vol. 37, pp. 336-351.
1951. *In* Muesebeck *et al.* Hymenoptera of America north of Mexico, synoptic catalogue. United States Dept. Agric., Agric. Monograph No. 2, pp. 1044-1049.

MORICE, F. D.
1904. Illustration of the male terminal segments and armatures in thirty-five species of the Hymenoptera genus Colletes. Trans. Ent. Soc. London, 1904, pp. 25-62, pls. 6-9.

NOSKIEWICZ, J.
1936. Die Palearktischen Colletes-arten, Prace Naukowe Wydawnictwo Towarzystwa Naukowego Lwowie, ser. 2, vol. 3, pp. 1-532.

PARKER, J. B. and A. G. BOVING,
1924. The blister beetle Tricrania sanguinipennis—biology, descriptions of different stages, and systematic relationship. Proc. United States Nat. Mus., vol. 64, pp. 1-40.

RADOSZKOWSKI, O.
1891. Révision des armures copulatrices des males du genre Colletes. Horae Soc. Ent. Rossicae, vol. 25, pp. 249-261.

RAU, PHIL and NELLIE
1916. Notes on the behavior of certain solitary bees. Jour. Anim. Behavior, vol. 6, pp. 367-370.

SCHMIEDEKNECHT, OTTO
1882-1884. Apidae Europaeae. Tomus 1. Gumperde et Berolini. 866 pp.

SINGH-PRUTHI, H.
1929. Homologies of the genitalia of insects. Ent. Monthly Mag., vol. 65, pp. 189-201.

SMITH, J. B.
1900. *In* [the Minutes of meeting of December 19, 1899]. J. New York Ent. Soc., vol. 8, p. 208.
1901. Notes on some digger bees. J. New York Ent. Soc., vol. 9, pp. 30-36.

SNODGRASS, R. E.
1941. The male genitalia of Hymenoptera. Smithsonian Misc. Coll., vol. 96, no. 5, pp. 1-85.

STÖHR, L. M.
1919. Une abeille canadienne, inaegnalis Say. Rapport de la Soc. de Québec pour la Protection des Plantes contre les Insectes et les Maladies fongueuse. Onzième Rapport, pp. 37-45.

STROHL, J.
1908. Die Copulationsanhänge der solitären Apiden u. die Artentstehung durch "physiologische Isolierung". Zool. Jahrb., Abt. Syst., vol. 26, pp. 333-384.

SWENK, M. H.
1908. Specific characters in the bee genus Colletes. Univ. Nebraska Studies, vol. 8, pp. 43-60.

TIMBERLAKE, P. H.
1943. Bees of the genus Colletes chiefly from Colorado. Bull. American Mus. Nat. Hist., vol. 81, pp. 385-410.
1951. Western bees of the genus Colletes (Hymenoptera, Apoidea). Wasmann Jour. Biol., vol. 9, pp. 181-238.

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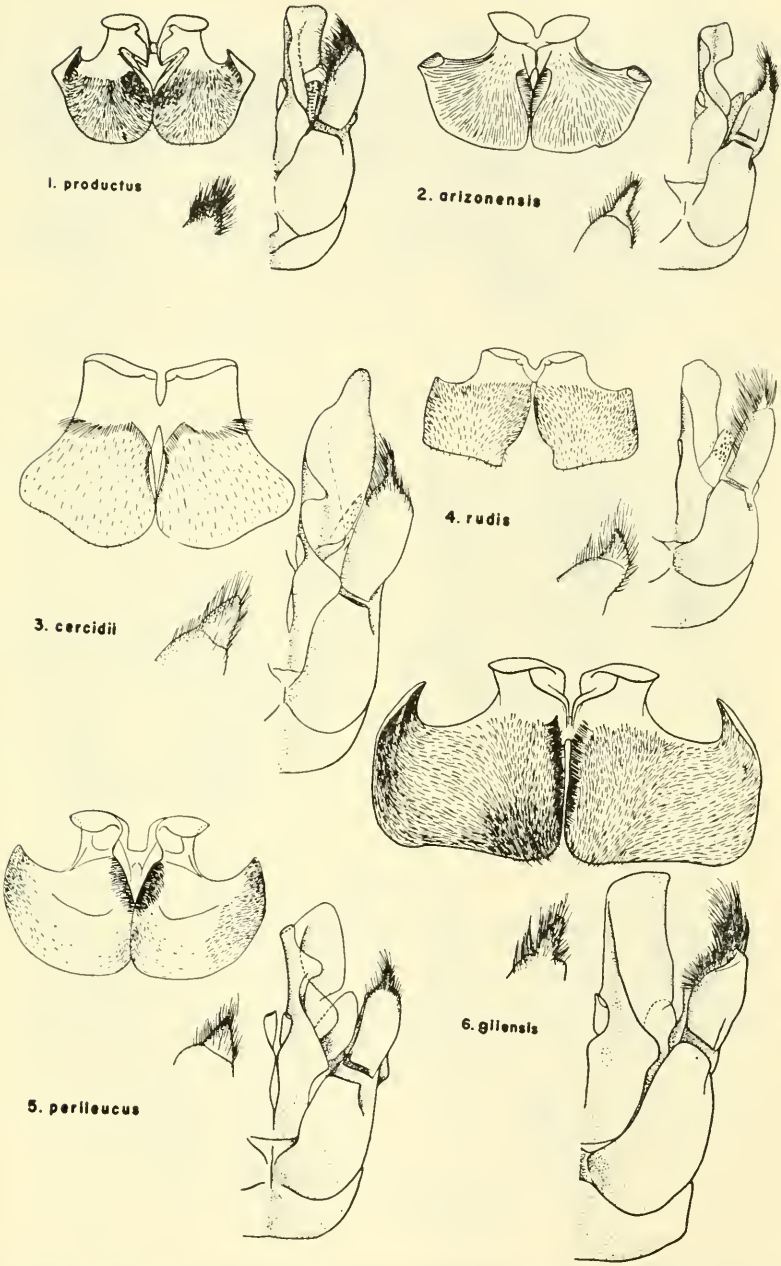
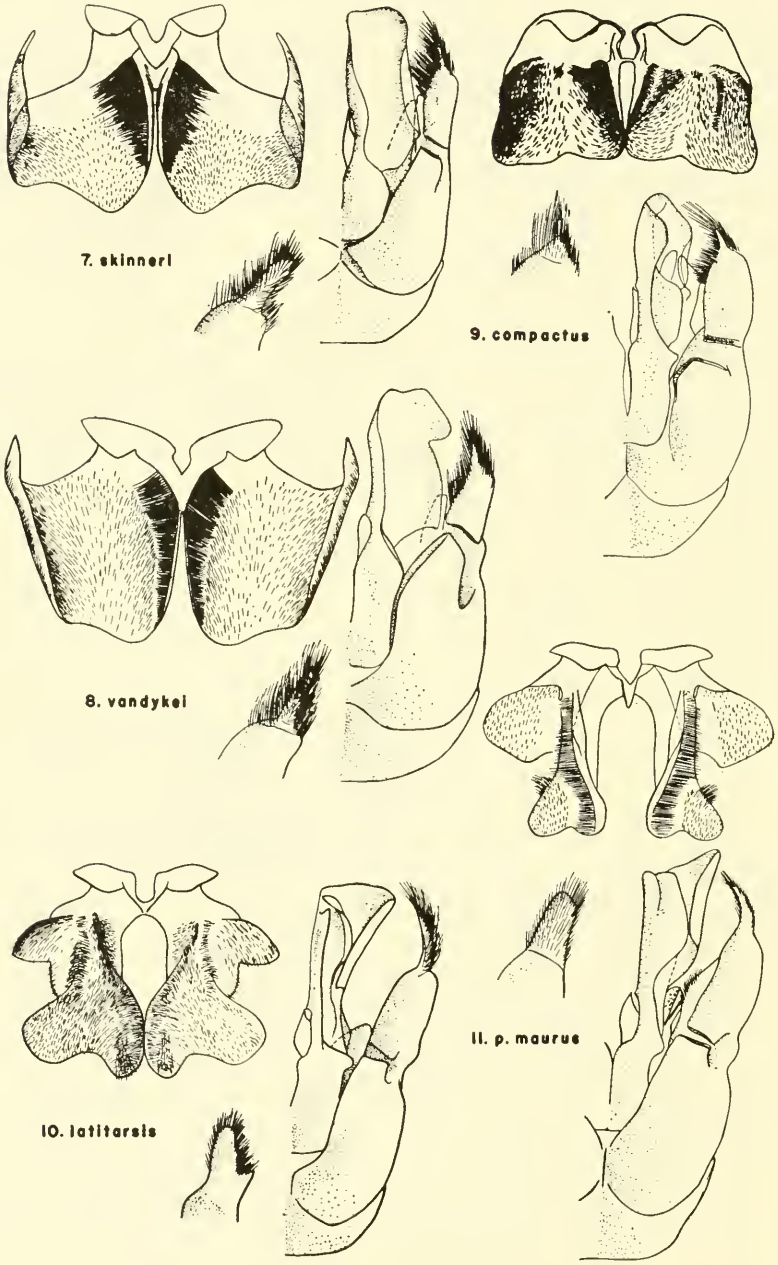
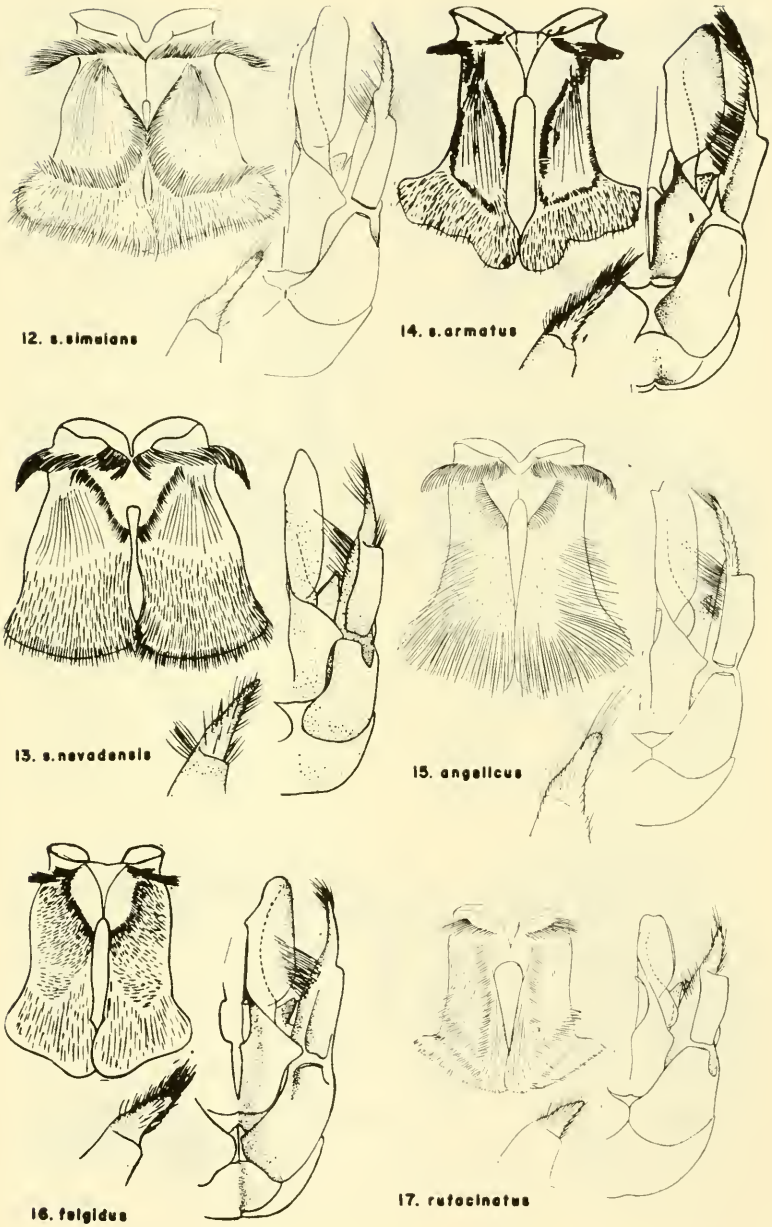


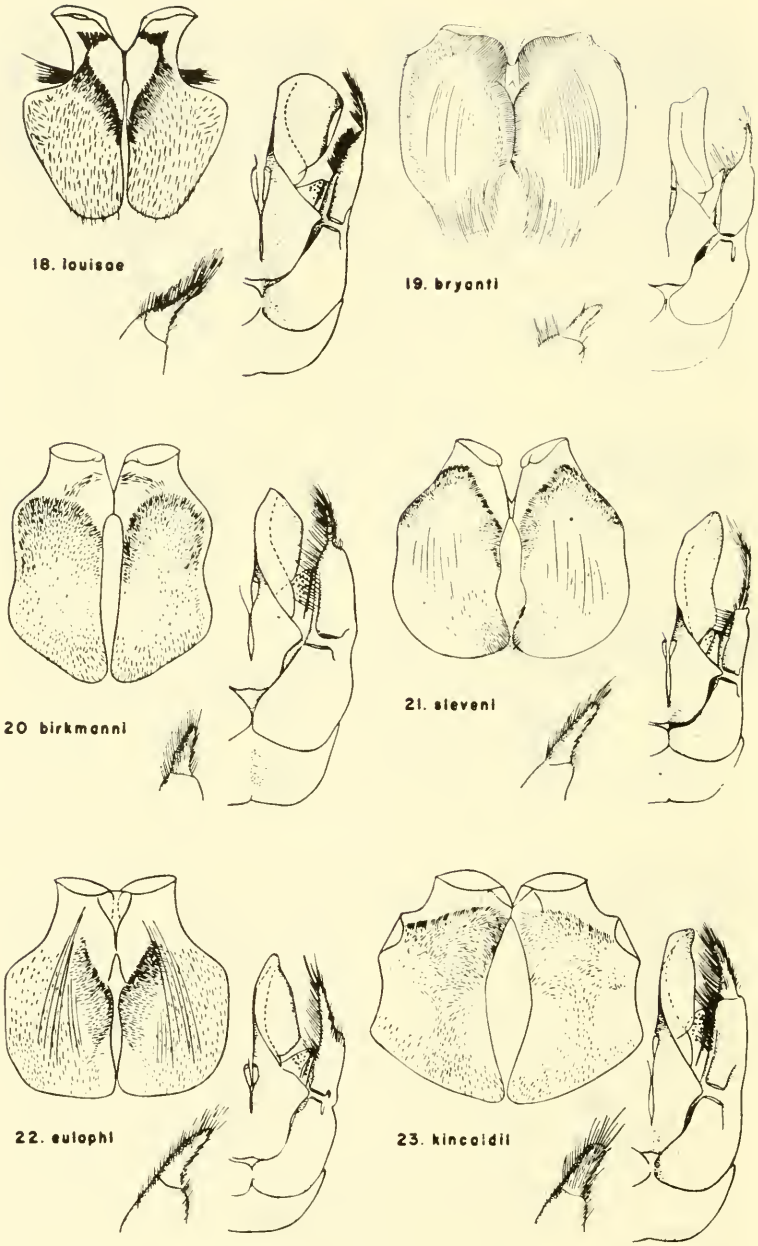

FIGS. 1-6. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



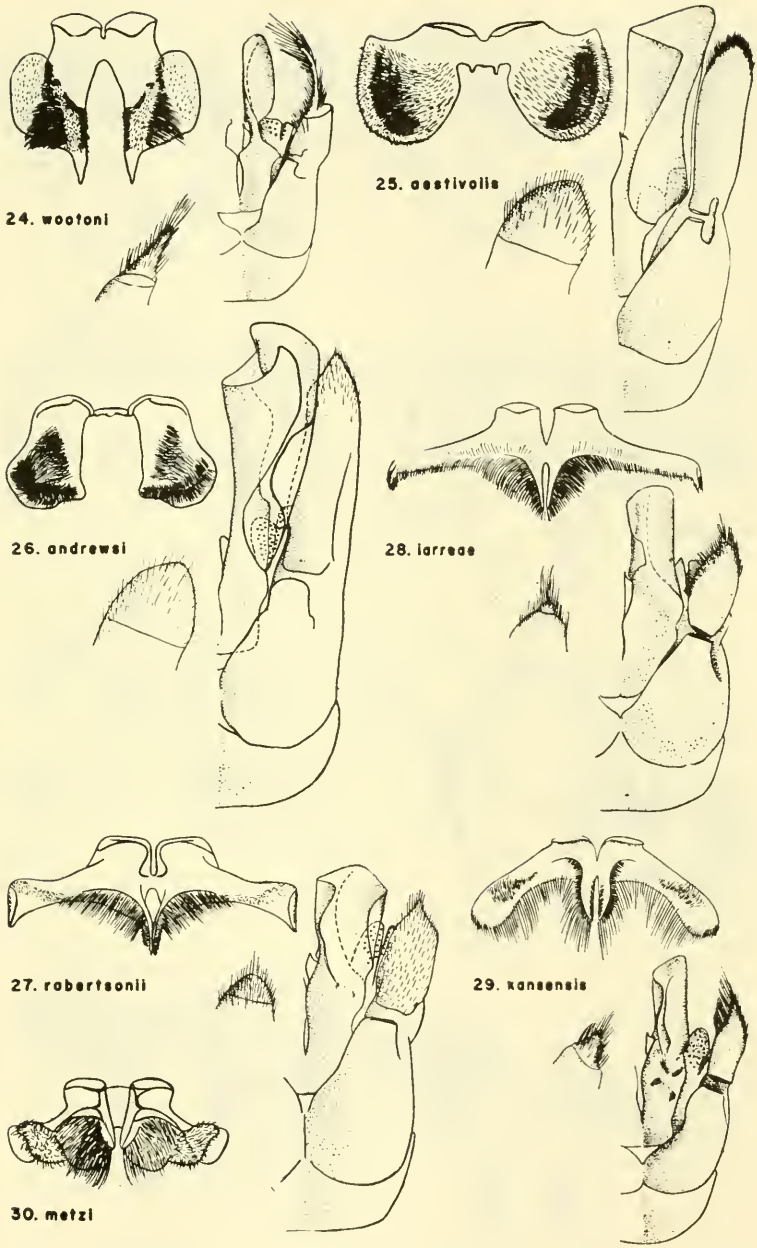

FIGS. 7-11. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



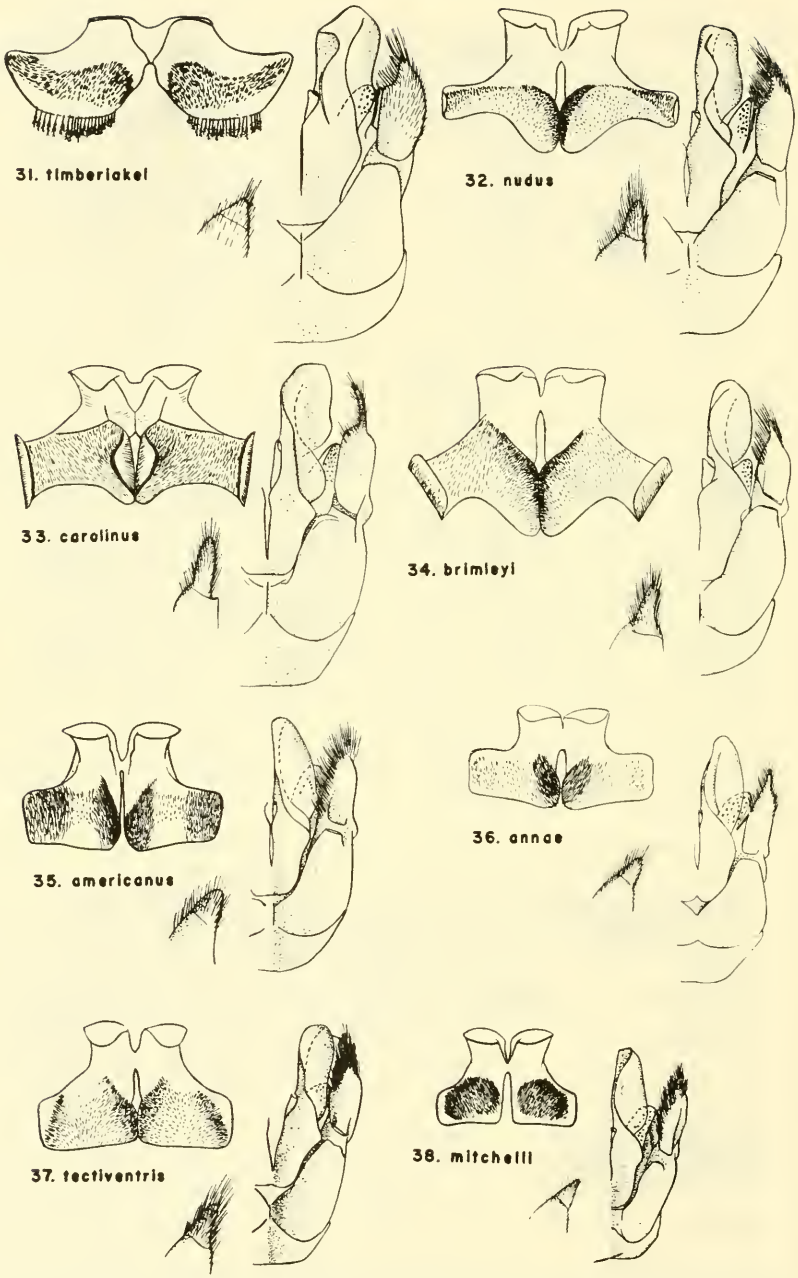

FIGS. 12-17. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



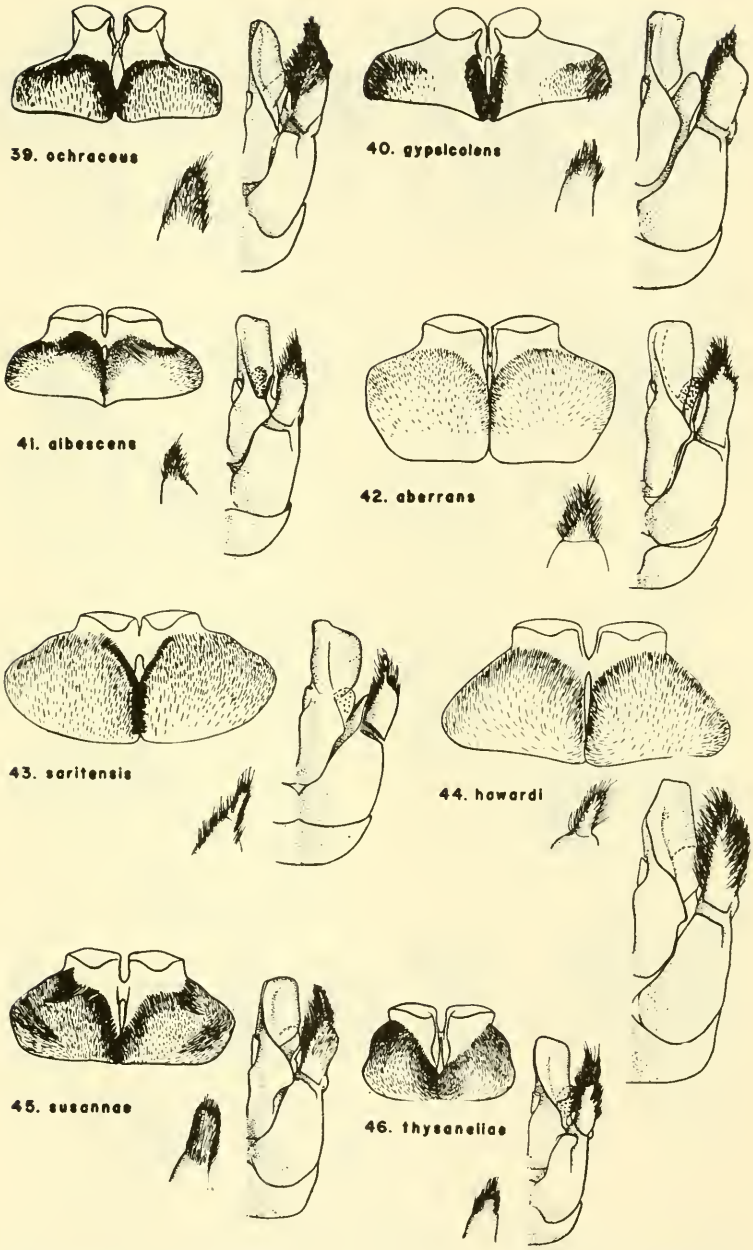

FIGS. 18-23. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



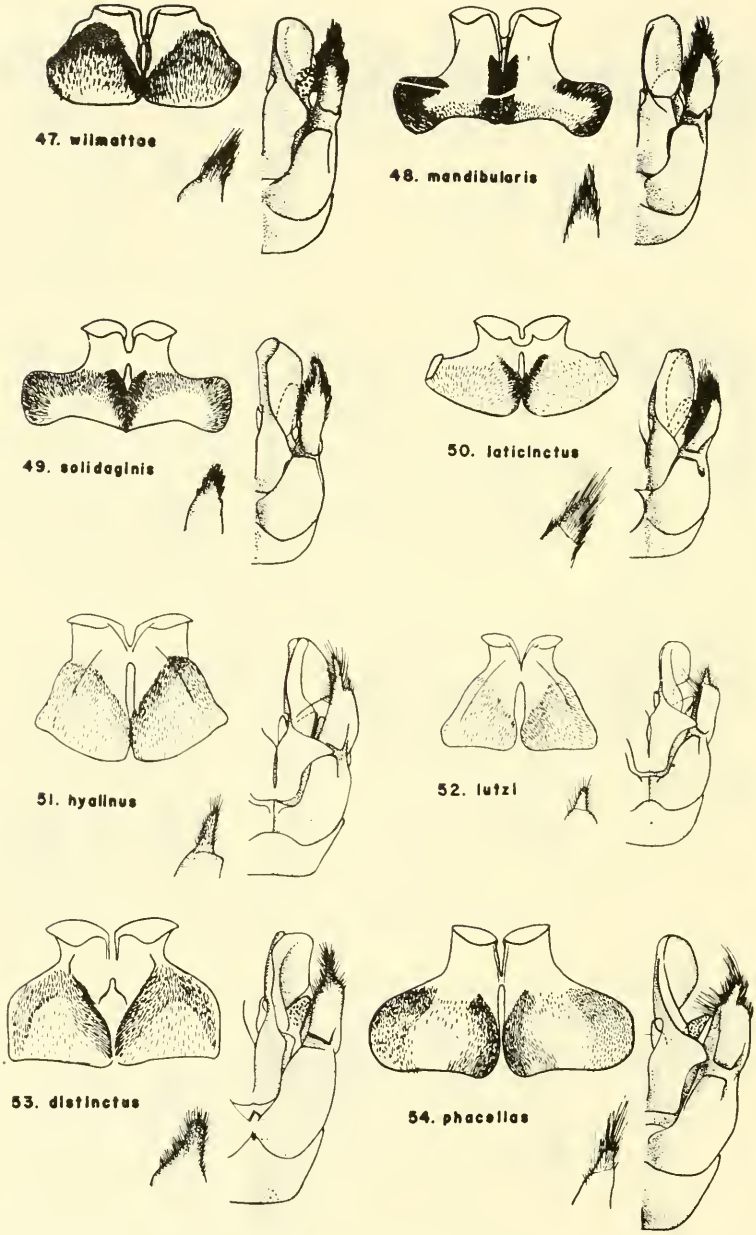

FIGS. 24-30. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



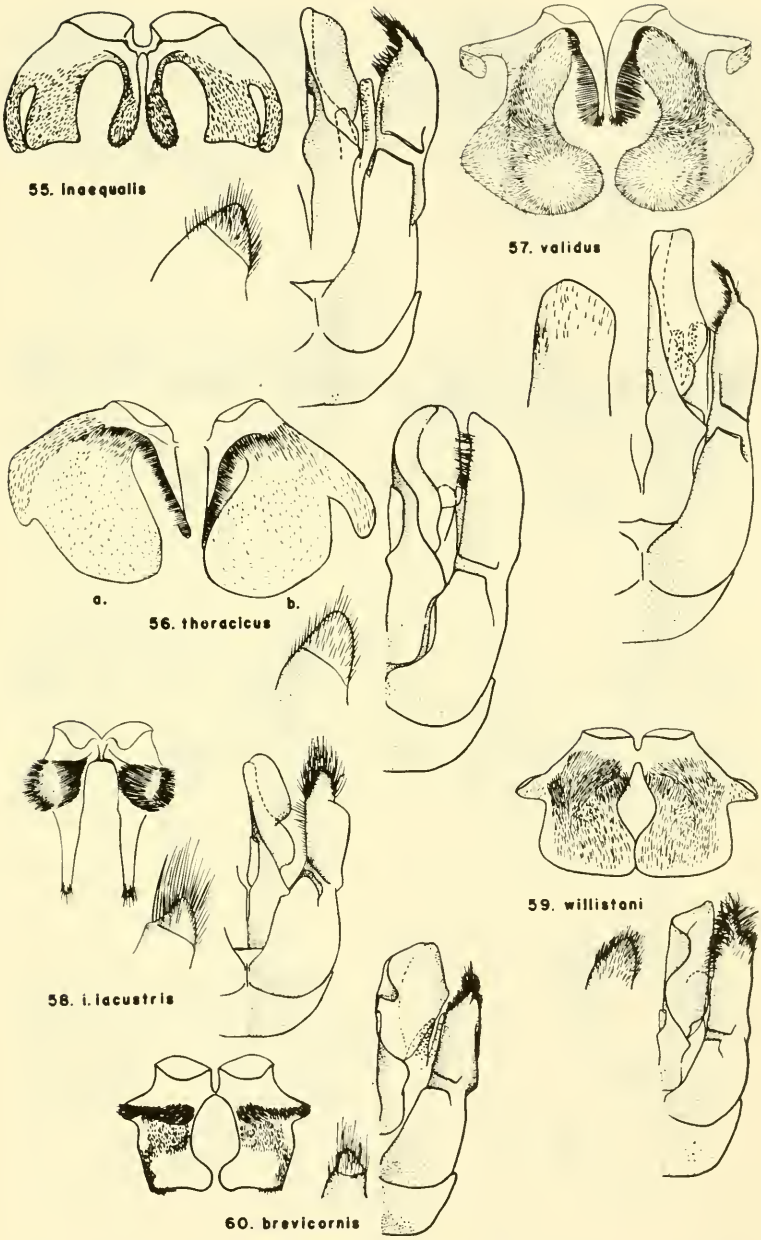

FIGS. 31-38. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



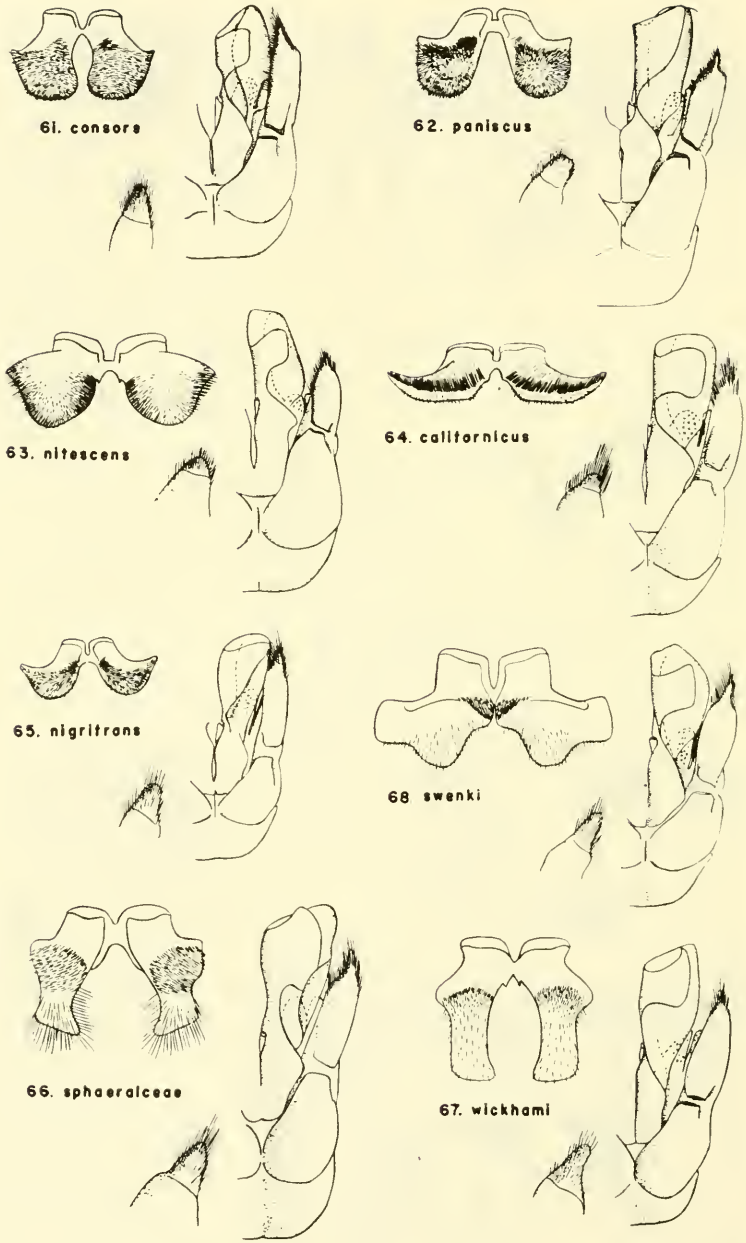

FIGS. 39-46. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



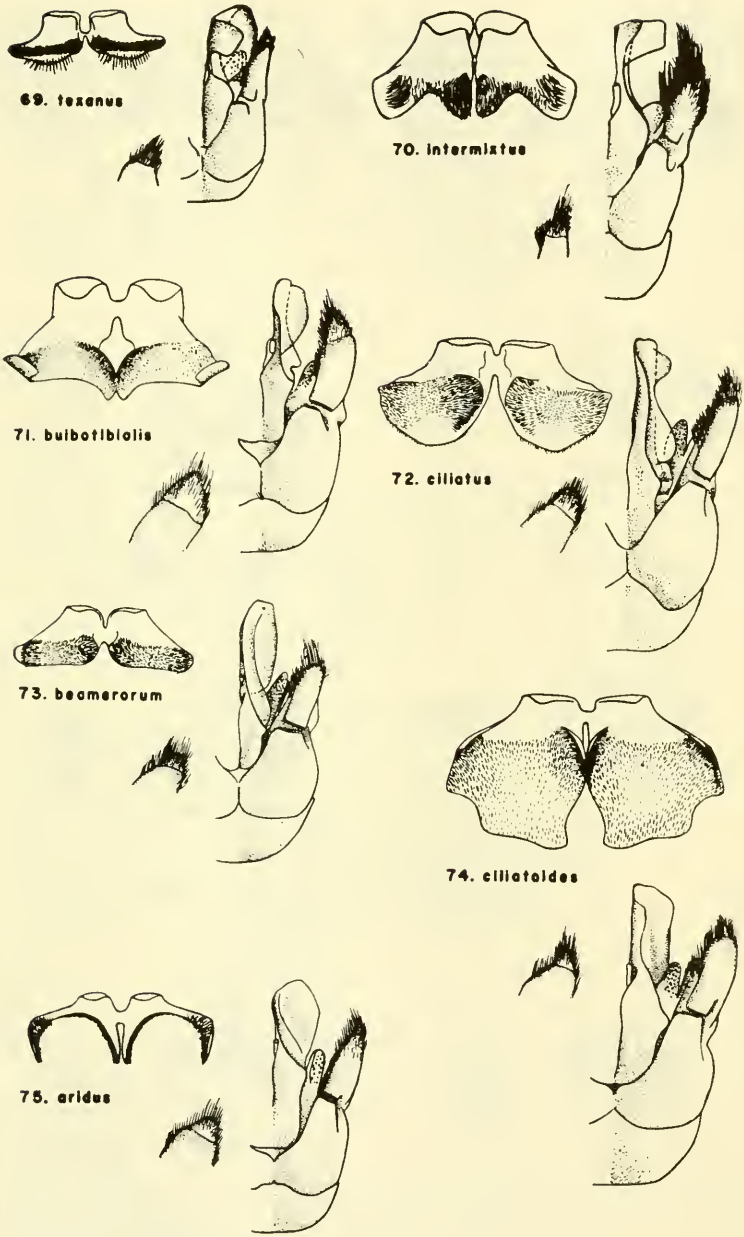

FIGS. 47-54. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



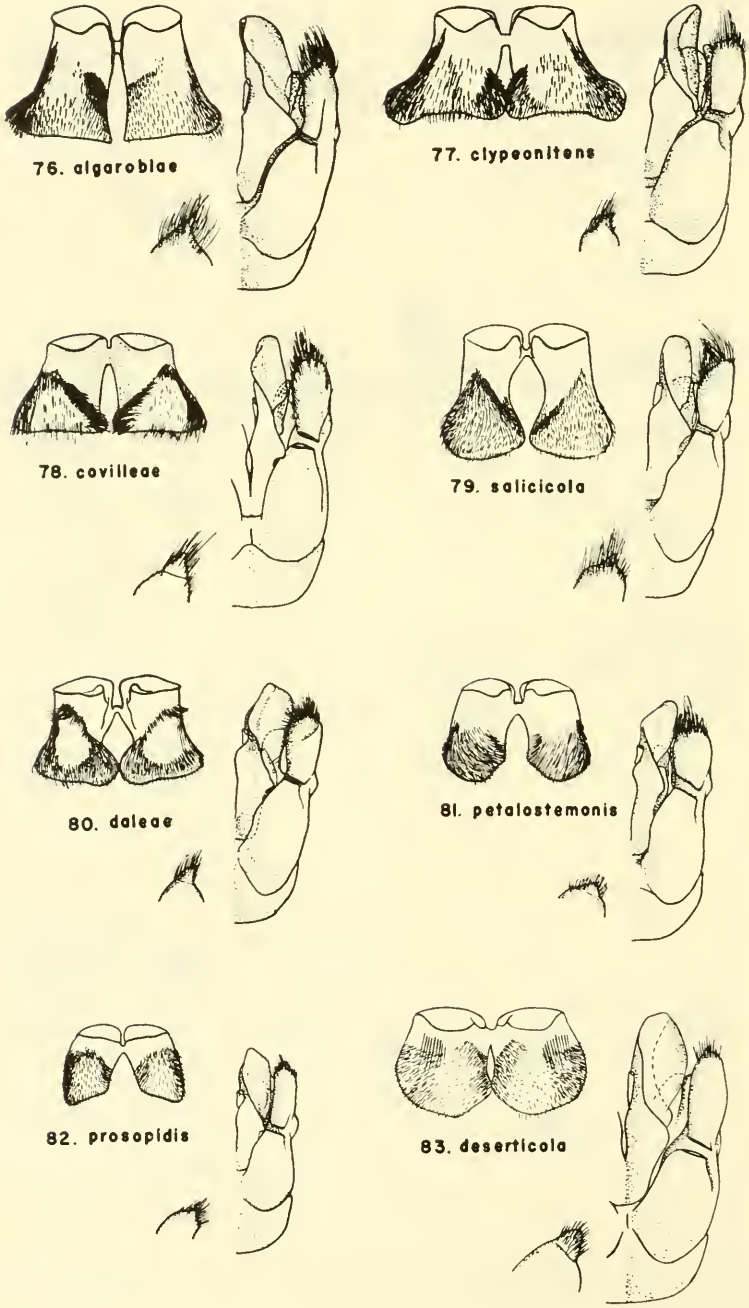

FIGS. 55-60. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.



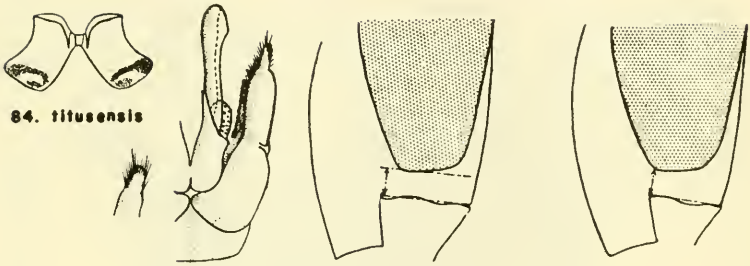

FIGS. 61-68. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.

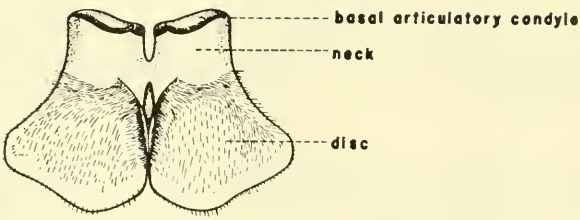



FIGS. 69-75. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.

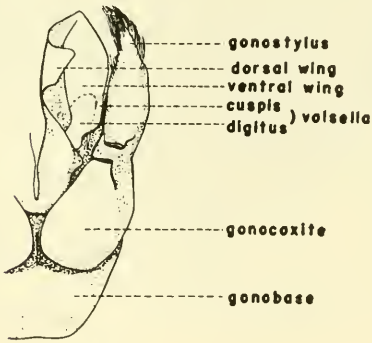



FIGS. 76-83. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.




86. seventh ventral plates



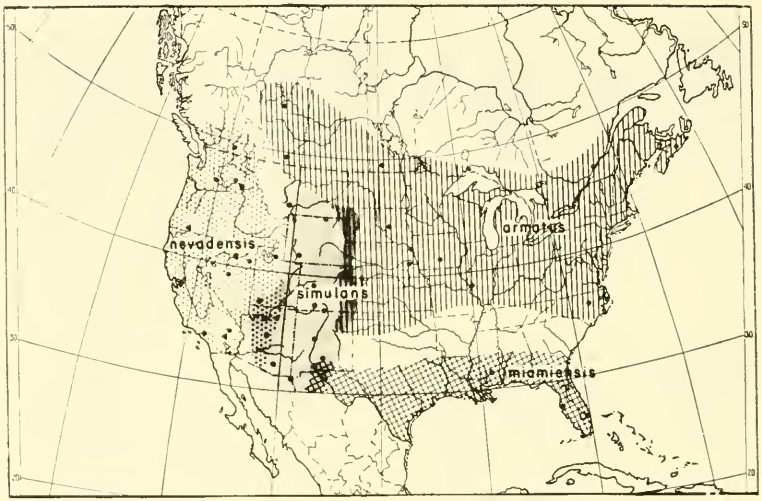

87. capsule

FIG. 84. Seventh ventral plates, left half of capsule and lateral view of left gonostylus of male.

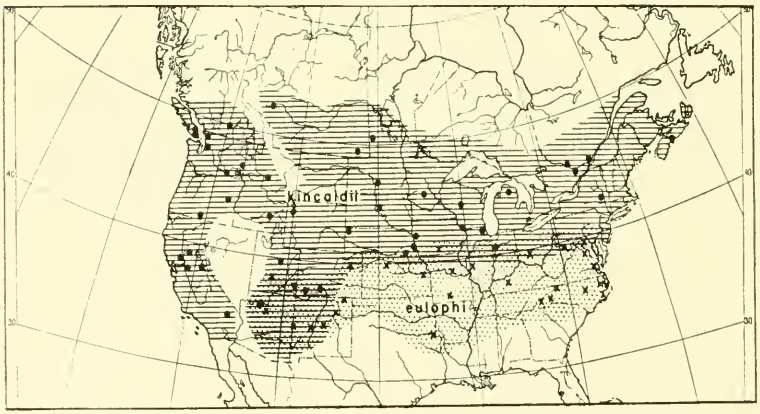
FIG. 85. Diagrams illustrating measurement of malar spaces.

FIG. 86. Elements of seventh ventral plates of male.

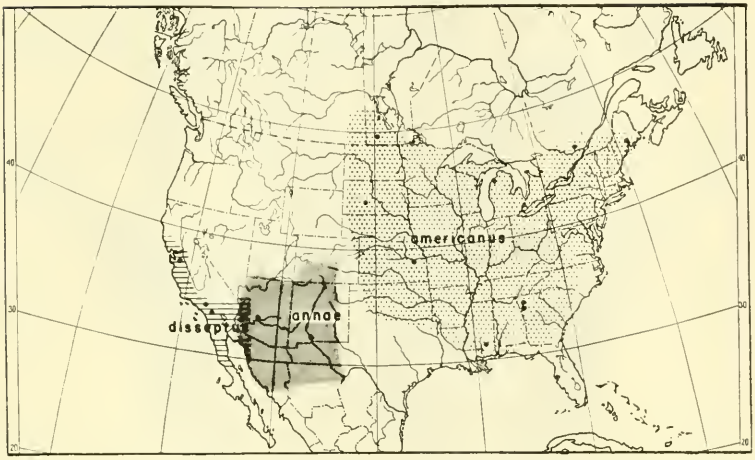
FIG. 87. Elements of capsule of male.



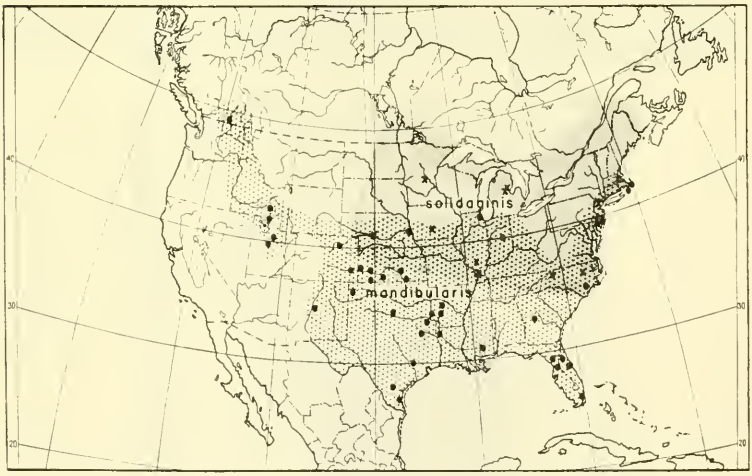

MAP 1. Map showing the distribution of *Colletes simulans*. The area of intergradation between the subspecies is indicated by the overlapping of types of shading.



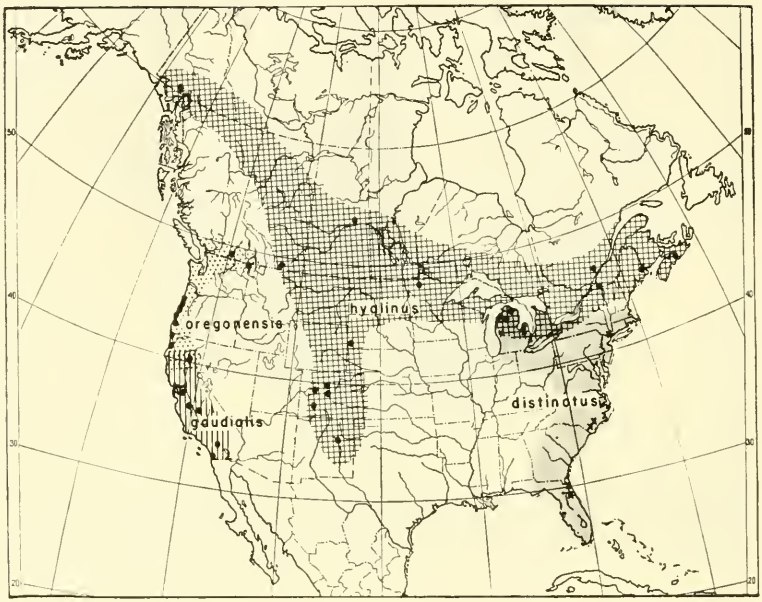

MAP 2. Map showing the distribution of *Colletes eulophi* and *C. kincaidii*.



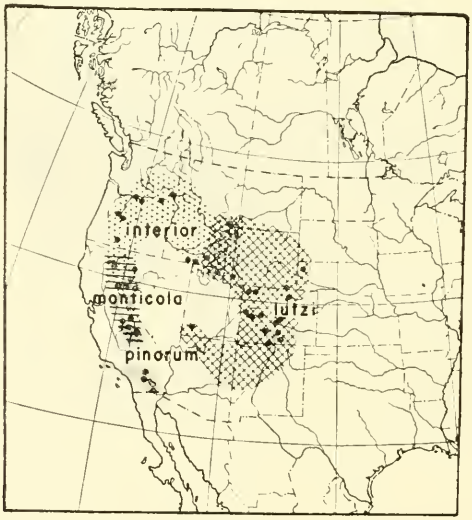

MAP 3. Map showing the distribution of *Colletes americanus*, *C. annae annae* and *C. annae disseptus*. The area of intergradation between the subspecies of *annae* is indicated by the overlapping of types of shading.



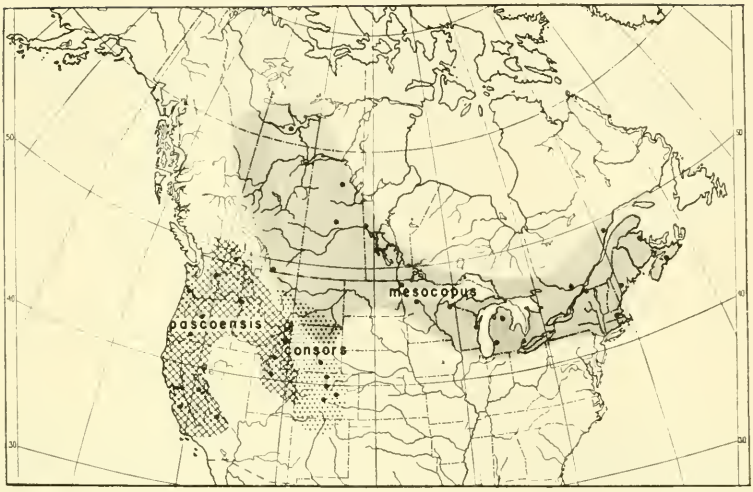

MAP 4. Map showing the distribution of *Colletes mandibularis* and *C. solidaginis*.



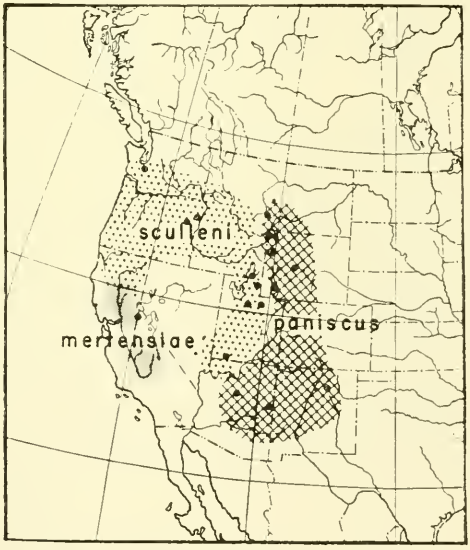

MAP 5. Map showing the distribution of *Colletes hyalinus* and *C. distinctus.* The area of intergradation between the subspecies of *hyalinus* is indicated by the overlapping of types of shading.




MAP 6. Map showing the distribution of *Colletes lutzi.* The area of intergradation between the subspecies is indicated by the overlapping of types of shading.




MAP 7. Map showing the distribution of *Colletes consors*. The area of intergradation between the subspecies is indicated by the overlapping of types of shading.




MAP 8. Map showing the distribution of *Colletes paniscus*. The area of intergradation between the subspecies is indicated by the overlapping of types of shading.

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# The Genus Rheumatobates Bergroth (Hemiptera-Gerridae)[1]

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ABSTRACT: This revision of the genus *Rheumatobates* removes it from the subfamily Halobatinae in the Gerridae to the subfamily Rhagadotarsinae. A key to twenty-three species and four subspecies is given with drawings of all species. *Rheumatobates* Bergroth 1892 includes as synonyms—*Hymenobates* Uhler 1894, *Telmatobates* Bergroth 1898 and *Hynesia* China 1943.

*Rheumatobates drakei* from British Guiana, *Rheumatobates spinosus* from Rio Purús, Brasil and *Rheumatobates crassifemur schroederi* from Ceará, Brasil are described as new.

The following are considered synonyms—*Rheumatobates wrighti* Drake and Harris 1937 syn. of *R. bonariensis* (Berg) 1898 . . . *Rheumatobates crinitus* Herring 1949 syn. of *R. vegatus* Drake 1942.

## THE GENUS RHEUMATOBATES

*Rheumatobates* is a New World genus of small water striders seldom over three millimeters in length and traditionally placed in the family Gerridae. It has no close relatives in the Western Hemisphere. The females are provided with an ovipositer for inserting the eggs into plant tissues, a character shared only by the genus *Rhagadotarsus* Breddin which is represented by the species *R. kraepelini* Breddin recorded from China, Formosa, Philippines, India, and Java, and I can add Sumatra and Burma, and *R.* (*Caprivia*) *hutchinsoni* China from Africa. For these species Lundblad[2] 1933 erected the Subfamily Rhagadotarsinae which he characterized as having:

1. The body dorsoventrally more or less compressed.
2. The head broad and short.

1. Contribution from University of Michigan Biological Station and No. 840, Department of Entomology, University of Kansas, Lawrence.

2. Lundblad, O. Zur Kenntnis der aquatilen und semiaquatilen Hemipteren von Sumatra, Java und Bali.—Archiv für Hydrobiol., Suppl., Bd. 12, 1933, pp. 411-412.

3. The region in front of the antennae not drawn out, the genae, as in the Hebridae, strongly formed and, as rounded disks, embrace the base of the rostrum. This is a special characteristic (according to Lundblad).

4. The eyes very large, prominent, the inner margins not concave, but descending obliquely toward the posterior.

5. Antennae of moderate length, first segment longest, accessory segments not present.

6. Rostrum reaching down between the front coxae.

7. Pronotum in the apterous form short, transverse, or in winged forms of moderate length covering the mesonotum with the posterolateral edges forming a half circle.

8. Mesonotum extensive with a median longitudinal furrow.

9. Mesonotum and mesopleurae separated by a longitudinal line.

10. Front legs strongly specialized with stout long femora, short tibiae and tarsi, the last tarsal segment much longer than the first and deeply cleft, the claws inserted in the cleft.

11. Hind legs much shorter than the middle legs.

12. Abdominal tip long drawn out in both sexes.

Most of the above statements apply also to *Rheumatobates*. Moreover both *Rhagadotarsus* and *Rheumatobates* have a median longitudinal line on the vertex of the head that is lacking in other Gerrids. While the genae are less conspicuous in *Rheumatobates* and the venation of the hemelytra is different in these two genera, I think they certainly belong in the same Subfamily and would remove *Rheumatobates* from the Halobatinae and place it in the Rhagadotarsinae.

That species in this strange group have led to the erection of new genera is not surprising. *Hymenobates* Uhler 1894 and *Telmatobates* Berg 1898 are undoubted synonyms of *Rheumatobates* Bergroth. In my studies of all the species of *Rheumatobates* I can find no line of demarcation to separate *Hynesia* China 1943 from *Rheumatobates* Bergroth 1892. Even the distinct bridgelike structure surrounding the dorsal shaft of the vesica in the male genitalia is not absent from some *Rheumatobates,* nine species of which have unmodified hind femora in the males and seven species of which have unmodified antennae in the males. No character of the head or thorax will separate *Hynesia* from *Rheumatobates,* the genae are slightly better developed in the two species of *Hynesia* than in some of the *Rheumatobates* but not in all. I am obliged therefore to consider *Hynesia* another synonym of *Rheumatobates.*

The genus *Rheumatobates* is one of the most remarkable groups of insects in the Hemiptera. All of the species are small gregarious surface striders and apterous adults far outnumber the winged forms so that they are overlooked by most collectors who mistake them for small nymphs of larger striders. For this reason these bizarre little bugs are not as well represented in collections as they deserve. The curious modifications of the antennae and legs of the males of many species are strange indeed!

## HISTORY OF THE GENUS

At the meeting of the New York Microscopical Society on May 15, 1891, Rev. J. L. Zabriskie exhibited "A curious unknown, aquatic, hemipterous larva" that he said was captured on July 11th, 1890, in a stream of the waterworks, Flatbush, Long Island. The minutes of this meeting were published in the October number of the Journal of the New York Microscopical Society (vol. 7, no. 4, 1891, pp. 128-129) and here we find Mr. Zabriskie's description and a creditable outline drawing of "Unknown aquatic larva. Magnified 10 diameters." The drawing is easily recognized as that of an adult apterous male water strider. Evidently he sent a sketch of the insect to C. V. Riley of the Division of Entomology in the U. S. Dept. of Agriculture at Washington, D. C., for determination, and at Riley's request forwarded the slide from which he had made the sketch. From the slide Riley recognized the insect as a member of the family Hydrobatidae (now Gerridae) and published a new drawing and description of it under the title "An Interesting Aquatic Bug" in Insect Life, vol. 4, Dec. 1891, pp. 198-200. He wrote, "It is impossible to say whether it is an immature or an adult form, but if adult, it will undoubtedly form a new genus in the family." When Riley's article came to the attention of Dr. E. Bergroth of Tammerfors, Finland he wrote a little note which was published in Insect Life vol. 4, June, 1892, p. 321. In this he recognized the drawing published by Riley as of an adult male insect and named it *Rheumatobates rileyi*, new genus and new species, stating that, "The presence of two ocelli (which Riley in his description said it possessed) and the remarkable structure of the antennae and of the hind femora are good generic characters of this insect."

Actually Riley was wrong in saying they have two ocelli for they have none and we now know of several species in which the males have neither modified antennae nor twisted legs.

Nevertheless, at the time Bergroth named *Rheumatobates rileyi*

from Riley's drawing and description, only the single apterous male was known and Riley's published drawing[3] of it has adorned the covers of the Proceedings of the Entomological Society of Washington since the beginning of volume 3 in 1893!

Riley was intrigued by this strange insect and was delighted when Mr. O. Heidemann donated to the National Museum a number of specimens collected along the Potomac Canal near Washington. In this lot besides males like *Rheumatomates rileyi* Bergroth, figured by Riley, there were females and nymphs and other males with unmodified hind legs. These latter males Riley considered "normal males" of *Rheumatobates rileyi* and the kind he had figured with bowed hind femora as "abnormal males." Therefore he published another paper in Insect Life, vol. 5, January, 1893, pp. 189-194, describing and figuring the "normal form" male of *R. rileyi*, the female and nymph, using figures made for him by Heidemann. In 1895 Meinert described Riley's *R. rileyi* "normal male" as *R. tenuipes* and "modified hind femora in males" was dropped from the generic concept of *Rheumatobates*. In 1932 Drake and Harris described *R. clanis* a species with normal antennae and legs, and in 1936 I described *R. minutus* and our concept of the genus was again modified and the strange and obvious characters that led Bergroth to establish the genus have been dropped. Nevertheless the genus *Rheumatobates* is a valid group of related species with a striking and pleasing assortment of specific characters as shown on the plates accompanying this paper.

Bergroth, 1908, gave a key to four species. Schroeder 1931 keyed out eight species and three varieties and did not mention *R. bonariensis* (Bergroth). Drake and Hottes 1951 listed twenty species and four varieties.

In this paper I am recognizing twenty-three species (two new) and four subspecies (one new). It is my conclusion, that *R. crassifemur esakii* Schroeder should be returned to the subspecies status as it was described; that there exists another subspecies *R. crassifemur schroederi* subsp. nov. that *R. crinitus* Herring is not even a good subspecies of *R. vegatus* but a synonym; that *R. wrighti* Drake and Harris is a synonym of *R. bonariensis* (Berg.); and that *R. imitator* (Uhler), *R. bergrothi* Meinert and *R. meinerti* Schroeder are good species.

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3. Heidemann probably made the drawing.

## *Rheumatobates* Bergroth

1892 Bergroth, E., Insect Life, vol. 4, p. 321 (citation of Riley's paper in Insect Life, vol. 4, p. 198, with brief statement of generic characters).
1896 Bianchi, V., Annuaire du Musée Zoologique de l'Académie Impériale des Sciences de St. Pétersbourg p. 71 (p. 3 of Extrait) (key to genera of Halobatinae).
1906 Kirkaldy, G. W., Trans. Amer. Ent. Soc., vol. 32, p. 156 (list of Genera).
1908 Bergroth, E., Ohio Naturalist, vol. 8, pp. 379-382 (key to known species and placing *Hymenobates* Uhler 1894 in synonymy).
1909 Kirkaldy, G. W., and Torre-Bueno, J. R. de la, Proc. Ent. Soc. Wash. X, p. 212 (catalog).
1911 Torre-Bueno, J. R. de la, Trans. Amer. Ent. Soc., vol. 37, pp. 245-246 (key to species of Atlantic States).
1911 Torre-Bueno, J. R. de la, Can. Ent., vol. 43, p. 228 (*Halobatopsis* Ashmead 1897 in part).
1916 Van Duzee, Edward P., Check List of the Hemiptera of America, North of Mexico, p. 49 (publ. by New York Ent. Soc.).
1917 Van Duzee, Edward P., Catalog of the Hemiptera of America, North of Mexico, p. 431 (Univ. of California Publ. Tech. Bull. College of Agri., Agricultural Exp. Sta. Entomology, Vol. 2).
1920 Hungerford, H. B., Kansas Univ. Science Bull., vol. 11, p. 116; 120 (key and life history notes).
1923 Torre-Bueno, J. R. de la, *in* Hemiptera of Connecticut, p. 663 (Connecticut State Geol. and Nat. History Surv. Bull. No. 34).
1926 Blatchley, W. S., Heteroptera or True Bugs of Eastern North America, pp. 981-985 (key).
1926 Esaki, Teiso, Annales Musei Nationalis Hungarici, vol. 23, p. 148.
1931 Schroeder, Herman O., Kansas Univ. Science Bull., vol. 20, no. 2, pp. 63-99, Plates VI-XI (key to known species).
1936 Deay, Howard O., and Gould, George E., American Midland Naturalist, vol. 17, No. 4, pp. 764-765.
1942 Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402 (lists the species).
1943 China, W. E., Proc. Royal Ent. Soc. London Ser. B., vol. 12, pp. 5-6 (comparative note).
1950 Larsen, Ossian, Opuscula Entomologica, vol. 15, 1, p. 40 (reduction of flight apparatus).
1951 Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, pp. 154-155 (list of known species).

The following are synonyms:
1894 *Hymenobates* Uhler, P. R., Proc. Zool. Soc. London for 1894, p. 214 [Erected for *R. imitator* (Uhler)].
1897 *Halobatopsis* Ashmead, W. H. (in part) (*nec* Bianchi 1896), Can. Ent., vol. 29, p. 56 (see 1911 Torre-Bueno, Can. Ent., vol. 43, p. 226).
1898 *Telmatobates* Berg, Carolo., Comunicaciones del Museo Nacional de Buenos Aires, vol. 1, no. 1, pp. 5-6 [Erected for *R. bonariensis* (Berg)].
1943 *Hynesia* China, W. E., Proc. Royal Ent. Soc. London, vol. 12, Pts. 5-6, Ser. B., pp. 71-72 (new genus for *H. trinitatis* and *H. mangrovensis* from Trinidad, B. W. I.).

Very small oblong or oblong-oval waterstriders, apterous or winged, with middle femora longer than hind femora. Head short. transverse, the eyes coarsely faceted, hemispherical, protruding beyond the prothorax laterally, and embracing it anteriorly. The vertex of the head with a median longitudinal shining or depressed line. The genae, disklike, and appressed against the base of the first segment of the beak, which is four segmented, short, surpassing

the tip of the front coxae. The antennae four-segmented without subsegments; in the males the basal segment often, but not always, the stoutest or longest. In many species the antennal segments of the male are strangely modified, as if for grasping, while they are normal in all females and in the males of some species. The pronotum short, the rear margin concave or sinuately concave in apterous forms. In winged forms the pronotum covers the mesonotum and is rounded behind. In apterous forms the mesonotum is elongate with a median longitudinal line. The genital segments are elongate in both sexes and appear more or less cylindrical in dorsal view. The male ninth segment lacks the claspers and the female is provided with an ovipositor for inserting the eggs in plant tissue.

The front legs are short. The femur usually as long or longer than the tibia and tarsus and, in the males often stout and provided with spines. The middle legs very long and in the males of some species modified. The hind legs much shorter than middle legs—normal in all females and some males but strangely modified in the males of certain species.

The original descriptions of many species have devoted considerable space to color and have had too little regard for the wide color variation that may occur within a species. Since I have given annotated bibliographies and have submitted drawings for all species I have shortened descriptions to include only those characters needed to verify the determination made by the use of the dichotomous key.

### The Genus RHEUMATOBATES Bergroth

(Key to males)

| | | | PAGE |
|---|---|---|---|
| 1. | Hind femur straight, segments of the leg unmodified | 2 | |
| | Hind femur not straight, some other segments may also be incrassate curved, twisted or spurred | 16 | |
| 2.(1) | Anterior femur stout with a tuft of stout hairs on anterior margin | 3 | |
| | Anterior femur may be stout but lacks tuft of stout hairs on anterior margin | 4 | |
| 3.(2) | Anterior femur with a dense fringe of very long hairs curved toward apex of femur. Females with anterolateral margin of head yellow — *R. (Hynesia) trinitatis* | p. | 536 |
| | Anterior femur without hair fringe described above. Females with anterolateral margin of head black, *R. (Hynesia) mangrovensis* | p. | 537 |
| 4.(2) | First antennal segment not incrassate, not possessing a stout hair tuft beneath | 5 | |
| | First antennal segment incrassate, possessing a stout tuft of hairs beneath | 13 | |

| | | | PAGE |
|---|---|---|---|
| 5.(4) | First antennal segment longest | 6 | |
| | First antennal segment not longest | 10 | |
| 6.(5) | Front femur with a conspicuous crooked row of long stout spines beneath that is double on basal third | *R. clanis* | p. 539 |
| | Front femur not as above | 7 | |
| 7.(6) | Last abdominal and first genital segment not deeply longitudinally grooved beneath | 8 | |
| | Last abdominal and first genital segment deeply, longitudinally grooved beneath | 9 | |
| 8.(7) | First genital broad, flat to slightly concave beneath with hairs on the sides. Front tibia with black peglike projections on inner margin | *R. petilus* | p. 540 |
| | First genital narrow, rounded beneath, not hairy, | *R. drakei* sp. nov. | p. 541 |
| 9.(7) | First antennal segment black | *R. bonariensis* | p. 542 |
| | First antennal segment with basal half pale | *R. b. wrighti* [4] | p. 542 |
| 10.(5) | Anterior femur considerably thicker than middle femur (17:11). Fourth antennal segment longest. First genital segment hairy | 11 | |
| | Anterior femur a little thicker than middle femur (12:10). Third antennal segment longest. First genital segment not hairy | 12 | |
| 11.(10) | Middle femur at least .9 length of insect | *R. vegatus* [5] | p. 544 |
| | Middle femur not more than .8 length of insect | *R. v. crinitus* | p. 544 |
| 12.(10) | Thorax mostly black above | *R. minutus* | p. 545 |
| | Thorax mostly flavous above | *R. m. flavidus* | p. 546 |
| 13.(4) | Middle femur distinctly bowed with a protuberence near the apex | 14 | |
| | Middle femur straight | 15 | |
| 14.(13) | Hind tibia straight | *R. creaseri* | p. 547 |
| | Hind tibia moderately bowed | *R. citatus* | p. 548 |
| 15.(13) | Middle tibia with basal third strongly arched or curved, then straight to tip | *R. praeposterus* | p. 549 |
| | Middle tibia straight | *R. tenuipes* | p. 550 |
| 16.(1) | Hind trochanter smaller than hind coxa | 17 | |
| | Hind trochanter incrassate, as thick as coxa | 22 | |
| 17.(16) | Front femur, above with a large prominent tubercle a little beyond its base. Abdomen beneath concave, the margins of the segments beset with extremely long hairs, strongly curved downward and inward, their tips nearly touching | *R. carvalhoi* | p. 551 |
| | Front femur without the above tubercle. Abdomen without the hairs described above | 18 | |

4. I have a long series taken from one place. All the males run to *R. bonariensis* (Bergroth) and females to *R. b. wrighti* Drake and Harris. Females in Bergroth's type series run to *R. wrighti* Drake and Harris.

5. I have not seen a specimen with middle femur "at least .9 length of insect," and do not believe *crinitus* is even a good subspecies.

18.(17) Hind femur without a median T-shaped projection on its inner surface ..... 19
Hind femur with a median T-shaped projection on its inner surface ..... *R. mexicanus* p. 552
19.(18) Hind femur hairless or at most with very short fine hair along the entire inner margin but may have some spinelike hair clusters at tip ..... 20
Hind femur with some long hairs ..... 21
20.(19) Posterior margin of middle femur with a row of long straight hairs, base and tip bare ..... *R. hungerfordi* p. 554
Middle femur nearly hairless except near tip .... *R. trulliger* p. 555
21.(19) Spur on terminal antennal segment at or beyond the middle, *R. rileyi* p. 557
Spur on terminal antennal segment before the middle, *R. r. palosi* p. 560
22.(16) Hind trochanter with a very long basal spur, *R. spinosus* sp. nov. p. 562
Hind trochanter not so armed ..... 23
23.(22) Hind trochanter inserted beyond the base of the femur. The femur without a T-shaped or anchor-shaped structure on its inner surface ..... 24
Distal end of hind trochanter joining basal end of femur. The femur with a T-shaped or anchor-shaped structure on its inner surface ..... 27
24.(23) A dense tuft of bristles extending forward from the basal extremity of the hind femur ..... *R. klagei* p. 563
Basal extremity of hind femur bare ..... 25
25.(24) Terminal antennal segment with a fairly uniform row of strong setae on the dorsolateral margin ..... 26
Terminal antennal segment with some very long stout setae in the dorsolateral marginal row .... *R. crassifemur esakii* p. 565
26.(25) Basal lobe of hind trochanter densely margined beneath with long hair ..... *R. crassifemur crassifemur* p. 564
Basal lobe of hind trochanter not densely margined beneath with long hair .... *R. crassifemur schroederi* subsp. nov. p. 566
27.(23) Hind trochanter not quite half as long as femur . *R. imitator* p. 567
Hind trochanter at least four fifths as long as femur ..... 28
28.(27) Intermediate tibia sinuate ..... *R. bergrothi* p. 568
Intermediate tibia straight ..... *R. meinerti* p. 569

## *Rheumatobates trinitatis* (China)

Plate VIII, figs. 8, 8a, 8b

1943 *Hynesia trinitatis* China, W. E., Proc. Royal Soc. London, vol. 12, pts. 5-6, ser. B, pp. 72-77, figs 1, 2a, and 4 (desc. from Trinidad, B. W. I.).
1948 *Hynesia trinitatis* Hynes, H. B. N., Trans. Royal Ent. Soc. London, vol. 99, p. 348.

Dr. China gives a splendid description and fine illustrations of this species so that it will be readily recognized.

*Size:* Apterous male 3.1 mm long and width across the middle of the mesonotum 1 mm. The apterous female is 3.7 mm long and 1.2 mm across the base of mesonotum.

*Color:* The detailed color description and the illustrations of both sexes by the author fit the paratypes I have seen very well indeed. It is probable that eventually some variation will be found but the large diamond-shaped dull black spot on the ochreous yellow head in both sexes and the two brown to black longitudinal stripes on the yellow front femur of the male may be distinctive.

*Structural characteristics:* Shape of the head characteristic of *Rheumatobates* with the usual curved bristles arising from the caudolateral surface of the eyes and others in front of the eyes. The antenna of the male with basal segment swollen and strongly curved upward in its middle, as seen in side view, other segments normal. The segmental formula being: 1st: 2nd: 3rd: 4th:: 47: 16: 14: 61. In the female: 30: 13: 19: 42. The front femur of the male somewhat incrassate, the basal half more or less compressed dorsoventrally, the apical half compressed laterally so that the whole femur has a twisted appearance. (see Plate VIII, fig. 8b). Other legs of the male unmodified.

*Location of types:* In British Museum.

*Data on distribution:* TRINIDAD, B. W. I. Described from Trinidad, from 7 males and 18 females taken by N. Hynes under mangrove.

### *Rheumatobates mangrovensis* (China)

Plate VIII, figs. 7, 7a, 7b

1943 *Hynesia mangrovensis* China, W. E., Proc. Royal Ent. Soc. London, vol. 12, pts. 5-6, ser. B. pp. 77-80, figs. 2b, 3, and 5 (desc. from Trinidad, B. W. I.).
1948 *Hynesia mangrovensis* Hynes, H. B. N., Trans. Royal Ent. Soc. London, vol. 99, p. 348.

This species is also described in detail and well illustrated.

*Size:* Apterous male 2.8 mm long, width across middle of the mesonotum .9 mm. The apterous female is 3.3 mm long and 1.1 mm across the base of the mesonotum.

*Color:* The color description and illustrations of both sexes by the author fit the paratypes I have seen. Probably some color variation will be found but the broad fulvous, somewhat U-shaped band on the base of the vertex with the rest of the head black as seen from above may prove constant. The front femur of the male is less strikingly marked and darker than in the preceding species.

*Structural characteristics:* Head of normal shape and as in *R. trinitatis* has the genae more developed than in some *Rheumatobates* species. The antenna of the male slightly modified, the first segment a little thicker than the others, slightly curved in both the dorsoventral and lateral planes and having two stout spines that are heavier than similar spines on the first segment of *R. trinitatis;* the second segment has one spine in both species. The antennal formula of the male being: 1st: 2d: 3rd: 4th:: 50: 16: 14: 24; for the female: 31: 13: 17: 25. The front femur of the male incrassate, dorsal surface (upper side) in the middle somewhat compressed above posterior edge, basal fourth of posterior side with a short shallow groove bounded at base on upperside by a distinct lobe or prominence; apical half of posterior (inner) side with a close-set row of strong black spines, longest in the middle, beginning at apex of upper posterior edge and curving inwards (*i. e.* downwards) to form at the middle of the femur an arc of three or four longer spines directed upwards instead of backwards; the lower edge of posterior side in middle with a much shorter, rather irregular row of black spines of varying lengths extending basally to well beyond end of the upper row of spines; ventral surface with two close-set convergent stout spines near anterior edge, placed about two thirds of length of femur from its base; also with a small short tuft of exceedingly close-set bristles, placed away from anterior edge, less than one half of length of femur from base; apical third of anterior (outer) side with dense but rather short pubescence; front tibia broad, scarcely swollen and laterally compressed, unarmed and without the tooth on the anterior side present in *H. trinitatis.* Other legs of male unmodified.

*Location of types:* In British Museum.

*Data on distribution:* TRINIDAD, B. W. I. Described from Trinidad, B. W. I., from 29 males and 34 females from Yarra River taken by N. Hynes.

*Comparative notes:* "Apart from the very differently shaped and armed antennae and front femora in the male, this species can be readily distinguished in both sexes from *H. trinitatis* by the black instead of yellow anterior lateral region of the head in front of the eyes; by the much wider, more transverse yellow spot in middle of pronotum; by the presence of a narrow longitudinal fulvous stripe down the middle of mesonotum in male and by the much broader mesonotal stripe in the female: the yellow stripe down the middle of the eighth abdominal tergite in female is much broader than in *H. trinitatis.*"

## *Rheumatobates clanis* Drake and Harris

Plate VII, figs. 6 and 6a

1932 *Rheumatobates clanis* Drake, C. J., and Harris, H. M., Pan. Pacific Ent., vol. 8, No. 4, p. 157-158 (desc. from British Honduras).
1936 *Rheumatobates clanis* Hungerford, H. B., Carnegie Inst. of Washington, Pub. No. 457, p. 148 (in key).
1942 *Rheumatobates clanis* Drake, C. J., and Harris, H. M., Rev. Brasil Biol. Soc., 2 (4), p. 402 (British Honduras).
1949 *Rheumatobates clanis* Herring, Jon, Florida Ent., vol. 32, No. 4, p. 160 (mentions only).
1951 *Rheumatobates clanis* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Wash., vol. 44, Pl. XIII a (British Honduras).

*Size:* Length of apterous males 2.1 mm to 2.38 mm [6] length of apterous females 2.73 mm to 3.17 mm [6].

*Color:* Velvety black with yellowish to fulvous markings. There is considerable variation in the extent of the pale markings. The rear margin of the vertex with flavous band that may be narrow or very broad; a quadrate, usually transverse pale spot on pronotum. Usually an elongate pale stripe on mesonotum although this may be lacking even in females. Sides of thorax more or less fulvous; a pale spot on the first genital of female.

*Structural characteristics:* The males of this species have the antennae, middle and hind legs unmodified. The antennal formula of the male is given by the authors as 27: 8: 11: 17 and for the female as 20: 8: 13: 18. The front legs of the male are stout and hairy, the femur incrassate with a crooked row of spines along the posterior margin beneath that becomes a double row on the basal half, beneath which there is often a heavy mat of light colored hair. In both sexes the pronotum is short with the sides strongly produced posteriorly. The first genital segment of the female with numerous long black setalike hairs as viewed from above.

*Location of types:* In the author's collection at Ames, Iowa, and three paratypes in Francis Huntington Snow Collection, University of Kansas.

*Data on distribution:* Described from apterous holotype male, apterous allotype female and 350 males and females taken with the types in Río Grande, British Honduras.

We have in the Francis Huntington Snow Museum of the University of Kansas the following: BRITISH HONDURAS: Río Grande, British Honduras, C. A., Nov. 1931. 1 ♂, 2 ♀ ♀ paratypes; February 1932, J. J. White. 48 ♂ ♂, 71 ♀ ♀. (6 ♂ ♂ have no pale spot on mesonotum); March 1932, J. J. White. 13 ♂ ♂, 146 ♀ ♀.

6. This maximum figure is the length given by the authors. I have seen none so large. Even paratypes are nearer the minimum figure

(3 ♂ ♂ have no pale spot on mesonotum); Punta Gorda, British Honduras, C. A., Aug. 1934. Purch. from Parish. 17 ♂ ♂, 7 ♀ ♀. (In this series 3 ♀ ♀ have the broad pale stripe on mesonotum, 3 ♀ ♀ with greatly reduced stripe, and 1 ♀ with black mesonotum. All the males have black mesonotum.) CUBA: Río Yumuri, Matanzas Prov. Matanzas, Cuba, June 11, 1932. P. J. Bermudez 97 ♂ ♂, 66 ♀ ♀. This is a new distribution record.

### *Rheumatobates petilus* Drake and Hottes

Plate VII, fig. 1.

1951 *Rheumatobates petilus* Drake, C. J. and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, pp. 147-149. (Desc. from Mex.)

*Size:* Length of apterous male 1.89 mm-2.3 mm[7]; length of female 2.55 mm[7]-2.77 mm.

*Color:* Brownish, to brownish black, with markings that are fulvous to whitish testaceous. The base of vertex of head with a broad fulvous U-shaped to V-shaped band. The pale pronotal spot, a truncated cone, the basal angles of which may be extended along the caudal margin of the pronotum for some distance; another pale elongate spot on lateral margin of pronotum behind each eye. The mesonotum usually has a fulvous to pale longitudinal median line or band. Another irregular pale figure lies laterally above the middle acetabula which are dark. Thoracic venter pale, abdominal venter dark in males. Females with a pale streak on the tergite of the first genital.

*Structural characteristics:* The males of this species have the antennae, middle and hind legs unmodified. The antennal formula of the male is given by the authors as 30: 12: 21: 26. For the female I find it to be the same. The front femur of the male is incrassate with a row of six or seven stout spines beneath the rear margin. The most striking characteristic of the species, not mentioned in the description, is a protuberence near the inner base of the front tibia of the male that bears two or three stout pegs. The first genital segment of the male is broad, flat to slightly concave beneath, with hairs on the sides.

*Location of types:* In the Drake Collection, Ames, Iowa.

*Data on distribution:* Described from holotype, allotype and two female paratypes taken from a large fresh water pond, Acapulco, Mexico, Aug. 3, 1951, C. J. Drake and F. C. Hottes.

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7. Measurement given by authors. My series compared with the types by Dr. Drake have apterous males that are 1.89 mm and apterous females that are 2.73 mm to 2.77 mm.

We have in the Francis Huntington Snow Museum the following: MEXICO: Hda. Balchakij, Río Champán, Campeche, Sept. 11, 1936, H. D. Thomas, 19 ♂ ♂, 12 ♀ ♀. Some were compared with the types by Dr. Drake.

*Rheumatobates drakei sp. nov.*

Plate VII, fig. 2.

*Size:* Length of apterous male 1.728 mm; width of head .68 mm; greatest width of body .796 mm. Length of apterous female 2.27 mm; width of head .69 mm; greatest width of body 1 mm.

*Color:* Black with a transverse rectangular pale spot on pronotum in both sexes. The males are otherwise black above, with venter black. The bases of antennae and front femora, all coxae and trochanters pale. The females above have large lateral spots on mesothorax and first genital segment pale, sometimes the tips of the connexivum are also pale and in some specimens there is a narrow median pale line on mesonotum. The venter is like the male except that the distal half of the last abdominal and first genital segment are pale.

*Structural characteristics:* The antennae and hind legs of the male unmodified. The segmental formula of antenna of male is: 1st: 2nd: 3rd: 4th:: 45: 18: 34: 28; for the female it is: 1st: 2nd: 3rd: 4th:: 34: 18: 35: 30. Front legs of male stouter than in female. The male femur plainly thicker than the middle femur (15:11) and both femur and tibia slightly curved. The femur with a row of about ten spines on rear margin. The front leg segments of the male have the following formula: Femur: tibia: tarsus:: 83: 65: 32. For the female: Femur: tibia: tarsus:: 73: 48: 32 with the femur no stouter than the middle femur but provided with a row of long spines on rear margin. The middle leg of male unmodified and long, the femur as long as the body, the segmental formula being: Femur: tibia: 1st tarsal: 2nd tarsal:: 225: 216: 92: 34. For the female: 225: 202: 107: 35. Few long hairs in either sex.

The posterior leg of male unmodified, the segmental formula being: Femur: tibia: 1st tarsal: 2nd tarsal: : 110: 123: 17: 21. For the female: 120: 102: 20: 25. Few long hairs in either sex. Metasternum of male depressed; ventral abdominal segments rounded, not hairy, the last abdominal slightly longer than the two preceding segments and nearly as long as the first genital. In dorsal view, the first genital, with sides tapering and not quite as long as last two

abdominal segments, not hairy. In the female dorsal view, the first genital a little shorter than the second and sparsely haired.

*Location of types:* Holotype male, allotype and thirty paratypes (17 ♂ ♂—13 ♀ ♀) are in the Francis Huntington Snow Museum of University of Kansas and bear the label "British Guiana, Supuruni Creek, Aug. 31, 1937 S. Harris."

*Comparative notes:* This is another little species with unmodified antennae and legs in the male. The first antennal segment of the male is longest which separates it from *R. minutus* Hungerford. Its antennae are shorter and stouter than in *R. petilus* Drake and the front legs of the male not so stout.

Since most of the other workers who have described valid species in this curious genus have been honored by naming species for them I am naming this species for Dr. Carl J. Drake who has described six species and two subspecies of *Rheumatobates* and who has had a lifelong interest in the semiaquatic Hemiptera.

### *Rheumatobates bonariensis* (Berg)

Plate VII, fig. 3.

1898 *Telematobates bonariensis* Berg, Carolo, Comunicaciones del Museo Nacional de Buenos Aires T. 1, no. 1, pp. 5-6 (desc. from Buenos Aires, Argentina).
1909 *Telmatobates bonariensis* Kirkaldy, G. W., and Torre-Bueno, J. R. de la, Proc. of the Entomological Soc. of Washington, vol. 10, p. 211.
1938 *Rheumatobates bonariensis* (Berg) Drake, C. J., and Harris, H. M., Notas del Museo de la Plata, T. 3, Zoologia no. 13, p. 201 (examined Berg's types).
1942 *Rheumatobates bonariensis* Drake, C. J., and Harris, H. M., Rev. Brasil Biol. 2(4), p. 402 (list the species).
1951 *Rheumatobates bonariensis* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, p. 154 (occurs with *R. bonariensis wrighti*).

The following are synonyms:
1937 *Rheumatobates wrighti* Drake, C. J., and Harris, H. M., Rev. de Entomologia, vol. 7, fasc. 4, pp. 360-361 (desc. from Buenos Aires).
1942 *Rheumatobates bonariensis* var. wrighti Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402
1951 *Rheumatobates bonariensis* var. wrighti Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, p. 154. (They say it is found with typical form.)

I have a long series taken from one place. All the males have the first antennal segment dark and all the females have the basal half of first segment pale. Moreover the females I have seen from Berg's type series have the base of first antennal segment pale. Since according to the last reference (1951) both occur together I cannot accept *R. wrighti* as a subspecies.

*Size:* Length of males 1.89 mm to 2.1 mm; length of females 2.25 mm to 2.52 mm.

*Color:* Typically a black species with some gray pubescence, the only pale spot being on the pronotum. The base of the antennae pale in the females and in some of the males. Venter usually dark brown to black, the coxae, trochanters and base of femora may be pale.

*Structural characteristics:* Antennae unmodified but with tip of distal segment curved down in male. Segmental formula: 1st: 2nd: 3rd: 4th:: 45: 19: 30: 38. In female: 1st: 2nd: 3rd: 4th:: 30: 18: 28: 33. The tip of antenna not curved. Legs also unmodified in the male.

The most striking character separating this species from others is not mentioned either in the description of *R. bonariensis* by Berg or in the description of *R. wrighti* by Drake and Harris and that is that the last abdominal and first genital segments of the male are deeply, longitudinally grooved beneath.

*Location of types: Telmatobates bonariensis* in Museo de La Plata, Buenos Aires, Argentina. *Rheumatobates wrighti* in the Drake Collection at Ames, Iowa.

*Data on distribution:* Both *R. bonariensis* Berg and *R. wrighti* Drake and Harris were described from Buenos Aires, Argentina.

We have in the Francis Huntington Snow Museum the following: ARGENTINA: Buenos Aires. Carded specimens of *Telmatobates bonariensis* from the Kirkaldy Collection, probably from Berg's type series, 2 ♂ ♂ and 1 ♀; specimen from "Delta" compared with type of *T. bonariensis* 1 ♂. Another one labeled "Bs. As." compared with type of *T. bonariensis* by M. S. Pennington. PERÚ: Perú, S. A. June 6, 1937, F. Woytkowski, No. 3769, Dept. Huanuca, Vic. of Afilador, Jungle, 800 m. a. s. l. 2 ♀ ♀, 6 ♂ ♂. In these the base of antennae black in males, pale in females. BRAZIL: São Paulo, Brazil X, 1947, R. Plaumann. 1 ♂, 2 ♀ ♀ in these base of antennae black in males, pale in females; Jabora, Brazil, X, 1947, F. Plaumann. 7 ♂ ♂, 7 ♀ ♀ base of antennae pale in both sexes; Nova Teutonia, 27-11 La., 52-23 Lo., XII, 1946, Fritz Plaumann. 12 apterous ♂ ♂, 30 apterous ♀ ♀, 21 winged ♂ ♂, 34 winged ♀ ♀. In above base of antennae black in males, pale in females; Nova Teutonia, 27-11 La., 52-23 Lo., V, 1948, Fritz Plaumann. 9 apterous ♂ ♂, 20 apterous ♀ ♀. Base of antennae black in males, pale in females.

From the above it is evident that with the exception of the specimens from Jabora, Brazil, all the males would run out in the key to *R. bonariensis* Berg and the females to *R. wrighti* Drake and

Hottes and since Drake and Hottes (1951) say that the two occur together and I can find no structural distinctions they must be one species.

### *Rheumatobates vegatus* Drake and Harris

Plate VII, fig. 5.

1942 *Rheumatobates vegatus* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), pp. 401-402. (Desc. from "Isle of Pines," Cuba.)
1949 *Rheumatobates vegatus* Herring, Jon L., Florida Ent., vol. 32, no. 4, p. 160. (Desc. *R. crinitus* from three counties in Florida from salt water and had Drake compare with *R. vegatus* Drake and Harris.)
1951 *Rheumatobates vegatus* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, p. 149 (adds Porto Rico and makes *R. crinitus* Herring a variety). I consider *R. crinitus* Herring a synonym of *R. vegatus* Drake and Harris.

*Size:* Length of apterous male 2.00 mm to 2.24 [8] mm; length of apterous female 2.68 mm to 2.95 [8] mm.

*Color:* Dark brown to nearly black with lighter markings as shown in Herring's paper (figure on his Plate I), except for a pale triangular spot behind the eye that is not shown in his figure. When *R. vegatus* and *R. clanis* females occur together, as they do in Cuba, the narrow median longitudinal mesonotal pale line, the pale triangular sport behind the eye on the side of the prothorax (distinguishes males also) and dark connexivum will distinguish *R. vegatus* females.

*Structural characteristics:* The males of this species have the antennae, middle and hind legs unmodified. The antennal formula of the male: 20: 10: 15: 22; for the female: 20: 10: 18: 23. Front femur of male moderately swollen about the middle, posterior margin with a straight row of about ten stout spines, above the basal end of which is a row of four longer more slender spines. In both sexes the pronotum is short with the sides strongly produced posteriorly.

The first genital segment of the female less spiny than in *R. clanis.*

*Location of types:* *R. vegatus* was described from a single apterous male from "Isle of Pines," Cuba and is in the Drake Collection. *R. crinitus* Herring was described from 365 specimens from various places in Florida. The holotype, allotype and some paratypes in the museum of Zoology, University of Michigan and paratypes in several private collections and in the Francis Huntington Snow Collection at University of Kansas.

8. Even the paratypes of *R. crinitus* Herring that I have seen are nearer the minimum figure than these starred figures which Herring gives.

*Data on distribution:* *R. vegatus* Drake described from Cuba. We have in the Francis Huntington Snow Museum the following: FLORIDA: Palm Beach Co. VI, 11, 1947, Jon Herring 3 ♂ ♂, 3 ♀ ♀ paratypes of *R. crinitus* Herring. CUBA: Río Yumuri, Matanzas Prov. Matanzas, Cuba, June 11, 1932, P. J. Bermudez 9 ♂ ♂, 7 ♀ ♀. PORTO RICO: San Juan, P. R., July 9-12, 1914, 1 ♀ (A. M. Nat. Hist.)

## *Rheumatobates minutus* Hungerford

Plate VII, fig. 4.

1936 *Rheumatobates minutus* Hungerford, H. B., Carnegie Inst. of Washington, publ. no. 457, pp. 147-148 (desc. from Yucatán, Mex.).
1937 *Rheumatobates minutus* Drake, C. J., and Harris, H. M., Rev. de Entomologia, vol. VII, fasc. 4, p. 362 (reports from "Puerto Rico").
1942 *Rheumatobates minutus* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), pp. 400-401 (report from Panamá and Porto Rico).
1949 *Rheumatobates minutus* Herring, Jon., Florida Ent., vol. 32, no. 4, p. 160 (compares with his *R. crinitus*).
1951 *Rheumatobates minutus* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, p. 155 (lists Mexico, Panamá, Trinidad, Perú).

*Size:* Length of apterous male 1.6 mm; of female slightly less than 2.2 mm.

Thus it is the smallest *Rheumatobates* so far described.

*Color:* Nearly black above; rear margin of head brown; light-brown irregular spot on pronotum; a larger one on mesonotum, which is broader behind, and in the female is broadly bilobate; a triangular light-brown spot on first genital segment of female; ventral side of head and thorax yellow, a dark band on sides of mesothorax extending from behind the eyes to the mesocoxae; abdominal venter of male black, genital segments with a yellow longitudinal band; abdominal venter of female yellow with basal segments darker; antennae and legs black except basal half of first antennal segment and the front femora beneath and at the base above.

*Structural characteristics:* Male with antennae, middle and hind legs unmodified. Antennal formula of both sexes about the same, being: 1st: 2nd: 3rd: 4th:: 14: 7: 19: 13. The front femora but slightly thickened in the male, with some slender hairs on caudal side but lacking a distinct row of strong spines. The formula for the male front leg segments being: 33: 23: 4: 11. For the female: 35: 20: 4: 12. The venter of thorax flattened to depressed.

*Location of types:* Holotype and allotype in University of Michigan Zoological Museum and two female paratypes in Francis Huntington Snow Museum of Univ. of Kansas.

*Data on distribution:* MEXICO: Described from one male and three females from Yucatán, Mex., Mérida, Niagra Cenote, July 21, 1932, E. P. Creaser. PORTO RICO: Mayaguez, Puerto Rico, Aug. 4, 1935, H. D. Tate, 1 winged male sent us by Dr. Drake. PANAMA: Panamá, Feb. 10, 1939, C. J. Drake, 22 specimens, apterous and winged of both sexes. (In Drake coll.)

*Rheumatobates minutus flavidus* Drake and Harris

1942 *Rheumatobates minutus* var *flavidus* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 401 (desc. from Perú).
1951 *Rheumatobates minutus* var *flavidus* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc., Washington, vol. 64, p. 155.

This subspecies has the most striking color pattern of any *Rheumatobates.*

*Size:* Stated by the authors to be a little larger than typical *R. minutus.* They give the length as 1.8 mm and width as 0.70 mm. The series I have measured vary for the males from 1.596 mm to 1.89 mm in length and for the females from 1.785 mm to 2.2 mm.

*Color:* The pattern for the apterous form is striking. The head is fulvous to darker with a paler line at base of vertex. The thorax orange to lemon yellow, sometimes with a flavous band laterally and a dark median spot on the caudal half. The genital segments pale. The abdomen black. The winged forms not so distinct from *R. minutus* but usually the front lobe of the pronotum is entirely pale and when it is not, all my specimens lack the dark band that extends from mesocoxa to the pronotum in *R. minutus.*

*Structural characteristics:* The hairs on the front femora are more conspicuous than in *R. minutus.* Otherwise the same.

*Location of types:* Haplotype apterous male, allotype female and paratype female, in the Drake and Harris collections.

*Data on distribution:* Described from "Shapajilla, Huánuco, Peru, Julho 1939." PERU: Type series above.

In the Francis Huntington Snow Museum we have the following: Dept. Huánuco, Loc. Shapajilla, Jungle, 630 m.a.s.l., Aug. 4, 1938, F. Woytkowski, 2 ♂ ♂, 2 ♀ ♀, all apterous; Dept. San Martín, Vic. Rioja, Soritor, Jungle, 900 m.a.s.l., Bog in forest, Oct. 19, 1936. F. Woytkowski, No. 3717. 1 ♂, 1 ♀, both winged; Dept. Huánuco, Vic. Leonpampa, Jungle, 800 m.a.s.l., Dec. 11-30, 1937. F. Woytkowski, No. 3811, 1 ♀ winged; Dept. Huánuco, Vic. Tingo Maria. Pond in clearing, 800 m.a.s.l., May 10, 1937. F. Woytkowski, No. 3772, 1 ♀ winged; Vic. Sani Beni, 840 m.a.s.l., Salt pool, 4% salt in jungle, Oct. 26, 1935. F. Woytkowski, No. 3559. 2 ♀ ♀

apterous. BRAZIL: Brazil, S. A., Vic. João Pessoa (São Phelipe) river Jurua, 7-10, 9-20, 1936. A. M. Olalla, No. 379. 3 ♂ ♂ (all winged), 9 ♀ ♀ (5 winged). Same as above except No. 375. 19 ♂ ♂ (11 winged), 15 ♀ ♀ (5 winged); *R. Amazonas* (Nrte), Region de Itacoatiara, Jan., Apr., 1936. A. M. Olalla, 1 ♂ (fully winged); R. Madeira, 9-37, Porto Velho, A. M. Olalla, 2 ♂ ♂, 1 ♀ (all apterous).

This subspecies was not previously known for Brazil.

### *Rheumatobates creaseri* Hungerford

Plate IX, figs. 10, 10a, 10b.

1936 *Rheumatobates creaseri* Hungerford, H. B., Carnegie Inst. of Washington, Publ. no. 457, pp. 146-147, text fig. of ♂ antenna, desc. from Yucatán, Mexico.
1942 *Rheumatobates creaseri* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402.
1951 *Rheumatobates creaseri* Drake, C. J., and Harris, H. M., Proc. Biol. Soc. Washington, vol. 64, p. 150 (completes desc. and compares with *R. citatus* sp. nov. records Acapulco, Mexico).

*Size:* Length of male 2.55 mm; of female 2.9 mm.

*Color:* The apterous forms are black. The interocular space dark brown to black. A yellow spot on the pronotum which is quadrate in the male, often nearly round in the female and attains anterior and posterior margins, a small yellow spot above each mesoacetabulum. Ventral side of head, meso- and metasternum and abdominal venter for the most part brown. Prosternum, mesopleurae, mesoacetabula, metacoxae and trochanters yellow. Anterior femora mosty pale. Antennae black, except basal segment in female which is mostly pale and the distal half of the third segment and basal part of fourth segment in the male which is pale yellow.

*Structural characteristics:* Antennae of male with basal segment incrassate, slightly longer than the head and provided with stout bristlelike hairs beneath, some of which are fused into a shiny black projection; second segment short, stout and with a basal spinelike hair beneath, third segment flattened, curved and longitudinally excavate beneath, a basal lobate projection beneath, a fringe of hairs on inner margin, distal segment pale at base and somewhat curved and tapering, basal third denticulate beneath; anterior trochanters of male produced beneath; anterior femora no thicker than middle femora and without conspicuous stout hairs. The middle femur rather stout, distinctly bowed, somewhat compressed laterally, sharply incrassate above apically, bifid behind with a broadly flattened hook curved around between the bifid ends; the

tibia slender, straight with a few long hairs near the middle. Hind legs straight.

*Location of types:* Holotype male, and allotype in University of Michigan Entomological Museum. Female paratypes in Francis Huntington Snow Museum of University of Kansas.

*Data on distribution:* Described from one male and three females from Yucatán, Mexico. Mérida, Niagra Cenote, July 21, 1932, E. P. Creaser. MEXICO: Yucatán, type series above; Acapulco, Aug. 3, 1951, Drake and Hottes, 6 specimens.

### *Rheumatobates citatus* Drake and Hottes

Plate IX, figs. 11, 11a, 11b

1951 *Rheumatobates citatus* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, pp. 150-152; 155. (Desc. from Mexico.)

*Size:* The authors give the length of apterous male as 2.75 mm. I do not have any apterous specimens of this species but have one male and five females with perfect wings. The over-all length to tip of wings of winged males is 3.67 mm, but the insect's body is only 2.52 mm long. The winged females in over-all length are from 2.94 mm to 3.15 mm, while the body length varies from 2.52 mm to 2.69 mm.

*Color:* The apterous forms "velvety black with testaceous markings". The winged specimens before me have black heads with a narrow band of fulvous at base of vertex; a transverse pale quadrate spot on pronotum and a round one above the middle acetabulum. Thoracic venter pale with brownish streaks on mesosternum behind front coxae; abdominal venter of male more or less embrowned. The antenna of male fuscous-black with the underside of first segment largely brownish testaceous, the apical third of the third and basal two thirds of fourth whitish testaceous; in the female, basal half of first antennal segment pale, otherwise dark.

*Structural characteristics:* The male antennae and middle and hind legs are distinctive and show close relationship with *R. creaseri* Hungerford. The first antennal segment is longer and less incrassate than in latter species. The second segment has a small bump beneath at the base, beneath which arises a tuft of fused long hairs, (see Plate IX, fig. 11a.); the distal segment shorter than in *R. creaseri.* The describers give the antennal formula for male: 1st: 2nd: 3rd: 4th:: 55: 13: 27: 17, for the female 11: 6: 12: 13. In the females I have measured there is little difference in the length of third and fourth segments. The front femur of the male is not in-

crassate, a little wider than the middle section of middle femur and provided on its caudolateral margin with a row of about six spines that are not as long as the diameter of the femur.

The middle femur is as shown on Plate IX, figs. 11, and 11b. The hind femur is decidedly longer than in *R. creaseri* and the hind tibiae are curved instead of straight.

*Location of types:* In the collection of the authors.

*Data on distribution:* MEXICO: The holotype, allotype and three male paratypes taken in the quiet waters of a small stream, about 20 miles south of Tehauntepec, Mex., July 23, 1951 by the authors. One paratype, Acapulco, Mex., Aug. 3, 1951, also taken by the authors.

We have in the Francis Huntington Snow Museum the following: Mexico, Dec. 7, 1932, A. Dampf, Mapastepec Chis. (Chiapas) Pacific Coast plain. At light. 1 ♂, 4 ♀ ♀ all with perfect wings: Another female taken at Tonalá, Chis., Nov. 3, 1932 by A. Dampf, at light.

### *Rheumatobates praeposterus* Bergroth

Plate X, fig. 12

1908 *Rheumatobates praeposterus* Bergroth, E., Ohio Nat., vol. 8, pp. 376-380, 382, figs. 4, 5 (desc. from Guatemala).
1909 *Rheumatobates praeposterus* Kirkaldy, G. W., and Torre-Bueno, J. R. de la, Catalogue *in* Proc. Ent. Soc. Washington, vol. 10, p. 212.
1931 *Rheumatobates praeposterus* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, No. 2, pp. 66 and 73-74.
1942 *Rheumatobates praeposterus* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402.
1951 *Rheumatobates praeposterus* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, p. 155.

*Size:* The apterous male length 2.02 mm. to 2.2 mm.; width across the head .84 mm. The apterous female length 2.56 mm.-2.9 mm.; width across the head .76 mm. to .798 mm.

*Color:* Brown to black, a quadrate pale spot on pronotum and a small round spot above the middle acetabula. Dorsum of abdomen frosted. First genital of female with or without a pale spot. Head brown beneath prosternum pale; mesosternum and abdominal venter brown.

*Structural characteristics:* The splendid description by Bergroth and the illustration given on Plate X will identify this species.

*Location of types:* Unknown to me. They are not in the Hine Collection at Ohio State.

*Data on distribution:* GUATEMALA, C. A.: This species was de-

scribed from four males, numerous females and some larvae from Puerto Barrios taken by Professor James S. Hine. We have received via the Kirkaldy collection 1 ♂, 2 ♀ ♀ from the cotype series. These are now in the Francis Huntington Snow Museum, University of Kansas.

### *Rheumatobates tenuipes* Meinert

Plate X, figs. 15, 15a

1898 *Rheumatobates rileyi* Riley, C. V., Insect Life, vol. 5, p. 190, fig. 18, as "normal male" of *R. rileyi* Bergroth.
1895 *Rheumatobates tenuipes* Meinert, Fr., Entomologiske Meddelelser, vol. 5, pp. 1-8.
1908 *Rheumatobates tenuipes* Bergroth, E., Ohio Naturalist, vol. 7, p. 377, fig. 3, antenna; p. 381.
1909 *Rheumatobates tenuipes* Kirkaldy, G. W., and Torre-Bueno, J. R. de la, Catalogue *in* Proc. Ent. Soc., Washington, vol. 10, p. 212.
1911 *Rheumatobates tenuipes* Torre-Bueno, J. R. de la, Trans. Amer. Ent. Soc., vol. 37, No. 3, p. 250.
1915 *Rheumatobates tenuipes* Bergroth, E., Bull. Brooklyn Ent. Soc., vol. 10, pp. 63-64 (records Bainbridge, Ga., in society with his new *R. trulliger*).
1916 *Rheumatobates tenuipes* Van Duzee, E. P., Check List of the Hemiptera, p. 49.
1917 *Rheumatobates tenuipes* Van Duzee, E. P., Catalogue of the Hemiptera of America North of Mexico, Univ. Calif. Publ. Tech. Bull. Entomology, vol. 2, p. 43.
1920 *Rheumatobates tenuipes* Hungerford, H. B., Kansas Univ. Sci. Bull., vol. 11, p. 116.
1920 *Rheumatobates tenuipes* Parshley, H. M., Psyche, vol. 19, p. 143.
1923 *Rheumatobates tenuipes* Torre-Bueno, J. R. de la, Univ. Iowa Studies in Nat. Hist., vol. 10, no. 3, p. 35.
1923 *Rheumatobates tenuipes* Wiley, Grace Olive, Can. Ent., vol. 55, p. 202 (comp. note).
1923 *Rheumatobates tenuipes* Torre-Bueno, J. R. de la, Connecticut Geol. and Nat. Hist. Surv. Bull., vol. 34, p. 663 (should be found in Conn.).
1926 *Rheumatobates tenuipes* Blatchley, W. S., The Hemiptera of Eastern North America, p. 982, fig. 196 on page 983, p. 984 (adds Glenn Echo, Md., and Raleigh, N. C., to D. C. record).
1926 *Rheumatobates tenuipes* Esaki, T., Annales Musei Nationalis Hungarici, vol. 23, p. 149 (says types are in Copenhagen Zool. Mus.).
1928 *Rheumatobates tenuipes* Drake, C. J., and Harris, H. M., Ohio Journ. Sci., vol. 28, no. 5, p. 273 (lists Md., Miss., Fla., and Tenn.).
1931 *Rheumatobates tenuipes* Schroeder, Herman O., Univ. Kans. Sci. Bull., vol. 20, no. 2, p. 66, p. 68-69 (a co-type in Snow Coll. K. U.).
1936 *Rheumatobates tenuipes* Hungerford, H. B., Carnegie Inst. of Washington, Pub. no. 457, p. 148 (in key).
1942 *Rheumatobates tenuipes* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 4-2.
1950 *Rheumatobates tenuipes* Herring, Jon L., Florida Ent., vol. 33, no. 1, p. 31-32 (records 5 counties in Fla. and says eggs inserted in stems and leaves of aquatic plants).
1951 *Rheumatobates tenuipes* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, p. 155 (lists).

*Size:* Apterous males, length 2.44 mm to 2.86 mm; over all length of winged male 3.86 mm. Apterous females, length 2.94 mm to 3.28 mm.

*Color:* Varies from specimens with a broad pale median longitudinal spot on the mesonotum in apterous forms to others that have the mesonotum entirely black. The mesosternum yellow with the anterior margin and two posteriorly diverging bands brownish black, these bands not reaching the posterior margin, dilated near the anterior margin. These bands will usually separate the females from those of *R. rileyi* which do not have these pronounced bands.

*Structural characteristics:* The males have antennae modified much as they are in *R. rileyi, R. trulliger* and *R. hungerfordi* but the hind femora are straight, not modified as in these species. The hairs on the middle femur are longer than in *R. rileyi.* The female antennal formula is: 1st: 2nd: 3rd: 4th:: 19: 9: 24: 25.

*Location of types:* Esaki says types are in Copenhagen Zool. Mus. Specimens some of them cotypes from the O. Heidemann collection were sent to Dr. Kirkaldy, and the following are now in the Francis Huntington Snow Museum at the University of Kansas: Washington, D. C. 9 VIII, '93, 2 ♀ ♀ ; Glen Echo, Md. 26 July 1894, 1 ♂ winged; Glen Echo, Md. 13 June 1897, 1 ♀ ; Glen Echo, Md. 27 July, '93 1 ♂ ; Glen Echo, 28 Sept. 1893, 1 ♂ ; Potomac Canal, Glen Echo, Md. 3-10-'92, 2 ♂ ♂ , 1 ♀ .

*Data on distribution:* MARYLAND and DISTRICT OF COLUMBIA: The type series. GEORGIA: Reported by Bergroth. NORTH CAROLINA: Reported by Blatchley. MISSISSIPPI: Reported by Drake and Harris. TENNESSEE: Reported by Drake and Harris. FLORIDA: Reported by Drake and Harris. I can add from the Francis Huntington Snow Museum the following: NORTH CAROLINA: Beaufort 7-9-'34. A. S. Pearse, 1 ♂ , 3 ♀ ♀ . VIRGINIA: New Church, 7-14-'33. L. D. Anderson, 2 ♂ ♂ , 2 ♀ ♀ ; Lake Drummond, 9-10-'33. L. D. Anderson, 1 ♂ , 1 ♀ . FLORIDA: Lake Jovita, 7-20-'34. P. McKinstry, 9 ♂ ♂ , 16 ♀ ♀ ; Apalachicola, 6-15-'35. A. S. Pearse, 4 ♂ ♂ , 6 ♀ ♀ ; Plant City, 8-15-'30. Paul W. Oman, 15 ♂ ♂ , 33 ♀ ♀ (many nymphs.)

### *Rheumatobates carvalhoi* Drake and Harris

Plate IX, figs. 9 and 9a.

1944 *Rheumatobates carvalhoi* Drake, C. J., and Harris, H. M., Rev. de Entomologia, vol. 15, fasc. 3, pp. 269-272, 1 fig. (desc. from Brazil).
1951 *Rheumatobates carvalhoi* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, p. 154.

*Size:* Length of apterous forms 2.9 mm to 3.0 mm.

*Color:* General color brownish black, with flavous and brownish markings, densely shortly pubescent. Head, except in front and

broad median dark fuscous stripe, yellowish brown; pronotum with large median quadrate area flavous, the sides brownish black; mesonotum brownish black; metanotum and abdomen brownish black without conspicuous markings. Head beneath, sternum, coxae and trochanters pale testaceous. Front femur testaceous, tibia brownish, tarsus blackish. Middle and hind legs brownish black.

*Structural characteristics:* The figure submitted by the authors and copied by me should identify this species. They give the antennal formula for the male: 1st: 2nd: 3rd: 4th:: 34: 5: 27: 23, and for the female: 20: 5: 24: 20. The male has stout front legs, the femora of which are somewhat compressed laterally, beneath with very long, brown, setalike hairs, above with a prominent tubercle a little beyond base. The other legs as shown on Plate IX. The abdomen beneath concave, the margins of the segments beset with extremely long brownish hairs, each tuft of hairs strongly curved downward and inward, their tips nearly touching. The genital segments slender, narrowed posteriorly, arched downward, the terminal segment shorter, the first segment beneath with raised margins.

*Location of types:* In collection of the authors.

*Data on distribution:* BRASIL: Carmo, R. Claro, Minas Gerais, Brasil, June 15, 1943, Dr. José Carvalho. Described from holotype male, allotype female, three paratypes, and known only from the above.

### *Rheumatobates mexicanus* Drake and Hottes

Plate XI, figs. 16, 16a; Plate XIV, fig. 27.

1951 *Rheumatobates mexicanus* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc. Washington, vol. 64, pp. 152-155 (desc. from Mexico).

*Size:* Length of apterous male 2.18 mm to 2.52 mm. Over-all length of winged male 3.15 mm. Length of apterous female 2.73 mm to 2.86 mm. Over-all length of winged female 3.03 mm.

*Color:* Apterous forms variable, black with more or less prominent testaceous markings. Head black with base of vertex flavous. Pronotum with pale spot often covering most of the dorsum. Mesonotum may have large diamond-shaped spot, none at all, a slender pale line, or a broad one. Abdominal dorsum black. The connexivum and genital segments may be pale or dark. Venter testaceous.

*Structural characteristics:* The authors give the antennal formulae as follows: For the male. 1st: 2nd: 3rd: 4th:: 45: 10: 28: 14. For the female 20: 9: 20: 25. The male antennae and hind legs are

modified. The male antenna with first segment moderately swollen, becoming thicker beneath from base for about two fifths its length, then thickest near the basal third, beneath with some long dark hairs, several of which are fused so as to form a long stout spinelike structure which is directed antero-downwards, becoming slenderer and almost cylindrical anteriorly, broadly constricted before the apex; segment two very short, at the base beneath with the fused hairs pointed downward; segment three moderately long, with some long dark stiff hairs beneath, strongly abruptly bent outwards near the base, on the lower side at the base with several long hairs fused so as to form an extremely long spinelike process, with a small bump before the apex on the outside, beneath near the apex with some long hairs fused, distinctly concave between bump and elbow on the outer surface; segment four rather short, concave and flattened beneath with apical part turned downwards, and with a couple bristly hairs.

The hind legs of male have "the hind coxae long, very strongly swollen thickest near the base, thence arcuately narrowed apically, clothed with very short pubescence, longer than the trochanters; trochanters moderately thick, with a few fine hairs beneath; femora rather short, very strongly bowed within, somewhat rounded basally, thence flattened and sort of scooped out on concave surface of apical fourth, clothed with numerous short hairs on entire dorsal surface, beneath just in front of small knob at base with long hairs fused so as to form a long dark spinelike process, another extremely long spinelike process a little before the apex, near the upper edge about the middle with a peculiarly modified flattened hairlike formation." The above description by the authors is difficult to visualize but my illustration on Plate XIV will show the slender stemmed anchorlike or T-shaped structure on the inner side of the hind femur.

*Location of types:* In the authors' collections.

*Data on distribution:* MEXICO: Acapulco, Mex., Aug. 3, 1951, Drake and Hottes. Type male, allotype female both apterous taken in a salt-water lagoon. Many other specimens apterous, macropterous and deälated males and females taken with the types.

The authors also took specimens in Aguascalientes, Puebla, Oaxaca, Tehauntepec, Mexico City, Ciudad Valles, Cuidad Victoria, Alvarado and Veracruz. They found them on fresh water as well as on brackish salt-water lagoons connected with the ocean. Dr. Drake kindly sent 6 male and 3 female paratypes to the Francis Huntington Snow Entomological Museum.

## *Rheumatobates hungerfordi* Wiley

Plate X, fig. 13.

1923 *Rheumatobates hungerfordi* Wiley, Grace Olive, Can. Ent., vol. 55, p. 202-205, pl. X (desc. from Texas and compares with *R. rileyi* Bergroth and *R. tenuipes* Meinert).
1928 *Rheumatobates hungerfordi* Drake, C. J., and Harris, H. M., Ohio Journ. Sci., vol. 28, no. 5, p. 274 (records Texas).
1931 *Rheumatobates hungerfordi* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, no. 2, pp. 72-73, Pl. XI, figs. 3-4 (records Texas and Utah).
1937 *Rheumatobates hungerfordi* Drake, C. J., and Harris, H. M., Rev. de Entomologica, vol. 7, fasc. 4, p. 362 (records Texas, Utah, N. M.).
1939 *Rheumatobates hungerfordi* Millspaugh, Dick D., Field and Laboratory, vol. 7, No. 2, p. 75 (probably over winter as eggs in Texas).
1942 *Rheumatobates hungerfordi* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402 (adds Ariz. and Mexico).
1951 *Rheumatobates hungerfordi* Drake, C. J., and Harris, H. M., Proc. Biol. Soc. Washington, vol. 64, pp. 149-150 (lists four places in Mexico).
1952 *Rheumatobates hungerfordi* Ellis, Leslie L., American Midland Nat., vol. 48, no. 2, pp. 323-324 (collected in Louisiana).

*Size:* Length apterous male 2.6 mm to 2.94 mm; of apterous female 2.73 mm to 3.25 mm; of winged male 3.78 mm to 3.86 mm; of winged female 3.44 mm to 3.57 mm.

*Color:* Velvety black, covered with a bluish-white bloom. Head black, sometimes with a flavous band at base of vertex. Pronotum with a large yellow spot occupying the entire length, in some specimens quadrate, in others twice as wide as long with sides rounded, while in some the spot covers the entire disk of the pronotum; mesonotum with a large median yellow spot, almost quadrate, or diamond-shaped in some specimens while in others it is roughly the shape of an inverted heart; a small spot above the mesoacetabula. In the winged forms only the yellow pronotal spot is visible. The basal half of the hemelytra are white with brown veins. The distal half embrowned. The transverse fracture line is white and from its middle a white line leads to the wing tip. Thoracic venter yellow with a brown band on mesosternum behind each front coxa, often the mesosternum is almost entirely dark. The abdominal venter in both sexes usually brown.

*Structural characteristics:* The female antennal formula is: 1st: 2nd: 3rd: 4th:: 20: 8: 20: 24. The male antennae and hind legs are modified as shown in the drawings. Mrs. Wiley has given a good detailed description of the species.

*Location of types:* The holotype, allotype, and morphotypes in Mrs. Wiley's collection. Paratypes in the collections of the University of Minnesota, University of Kansas, and the private collections of Wm. E. Hoffmann and Mrs. Wiley.

*Data on distribution:* TEXAS: Rock Island, Texas, Aug. 2, 1922. Grace O. Wiley. Apterous male Holotype. Rock Island, Texas, June 27, 1922. Grace O. Wiley. Apterous female Allotype. Morphotype male (macropterous form) June 6, 1922 at type locality. Morphotype female (macropterous form) May 23, 1922 at type locality. Various paratypes taken from April to September at above place. Others from Galveston and Cisco, Texas.

We have in the Francis Huntington Snow Museum at the University of Kansas from Texas the following: Paratypes from Rock Island, Texas, 1 ♂ 1 ♀; paratypes from Colorado Co., Texas, 2 ♂ ♂, 2 ♀ ♀. Colorado Co., Texas, 5/5/1922. Grace Olive Wiley, 2 ♂ ♂ (1 winged) 1 ♀ (winged). Colorado Co., Texas, July 11, 1922. Grace Olive Wiley, 8 ♂ ♂, 5 ♀ ♀ (all apterous). Colorado Co., Texas, 5/8/1922. Grace Olive Wiley 3 ♂ ♂ (all winged) Colorado Co., Texas, 4/24/1922. Grace Olive Wiley, 4 ♀ ♀ (all winged). Kerr Co., Texas, 7/21/1928. L. D. Beamer, 14 ♂ ♂ (5 winged). Menard Co., Texas, 7/19/28. R. H. Beamer, 7 ♂ ♂, 1 ♀ (all apterous). Tom Green Co., Texas, 7/15/28. R. H. Beamer, 1 ♂ (winged, 2 ♀ ♀ (apterous). Hidalgo Co., Texas, 7/28/28. A. M. James, 1 ♀ (apterous). Kendall Co., Texas, 7/22/28. J. G. Shaw, 9 ♂ ♂ (1 winged). McAllen, Texas, 11/20/32. L. D. Tuthill, 5 ♂ ♂ (1 winged) 6 ♀ ♀ (1 winged).

ARKANSAS: Polk Co. Ark., 8/21/28. R. H. Beamer 2 ♀ ♀ (apterous). OKLAHOMA: Ketchum Okla., 10/11/32. L. D. Tuthill, 1 ♂ (apterous). UTAH: Emery Co., Utah, Aug. 2, 1922. Mrs. Grace Wiley, 1 ♂ (winged), 5 ♀ ♀ (4 winged). MEXICO: Valles, Mex., Aug. 8, 1951. C. J. Drake, 1 ♀; July 17, 1950, Drake and Hottes, 1 ♂ (apterous). Piedras Negras, Ver Costal Plain, Mex., 10/18/26. Dr. Dampf, 4 ♀ ♀ (winged).

## *Rheumatobates trulliger* Bergroth

Plate X, Fig. 14

1915 *Rheumatobates trulliger* Bergroth, E., Bull. Brooklyn Ent. Soc., vol. X, pp. 63-73 (desc. from Bainbridge, Ga., in society with *R. tenuipes*).
1917 *Rheumatobates trulliger* Van Duzee, E. P., Catalogue of the Hemiptera of America North of Mexico, Univ. of Calif. Publ. Tech. Bull. Ent., vol. 2, p. 431.
1920 *Rheumatobates trulliger* Hungerford, H. B., Kansas Univ. Sci. Bull., vol. 11, p. 116 (footnote).
1926 *Rheumatobates trulliger* Blatchley, W. S., Heteroptera of Eastern North America, pp. 984-985.
1928 *Rheumatobates trulliger* Drake, C. J., and Harris, H. M., Ohio Journ. Sci., vol. 28, no. 5, p. 274 (records Tenn. and Miss.).
1931 *Rheumatobates trulliger* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, no. 2, p. 72, pl. VI, fig. 3, p. 85, pl. XI, figs. 5-6 (records Kansas and Arkansas).

1942 *Rheumatobates trulliger* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402 (lists).
1951 *Rheumatobates trulliger* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc., Washington, vol. 64, p. 155 (lists).

*Size:* Length of apterous male 2.5 mm. to 2.8 mm. Over all length of winged male about 3.36 mm. Length of apterous female 2.73 mm. to 3.15 mm.

*Color:* The pattern much the same as in *R. rileyi* Bergroth and subject to considerable variation. The head is black, with or with out a fulvous line at base of vertex. The pale spot on the pronotum may be narrow, nearly square reaching both front and rear margins or it may be broad covering most of the pronotum. In the apterous forms the pale spot may be broadly heart-shaped, triangular, diamond-shaped, arrow-shaped, a slender line, or absent entirely. The connexivum may be black, margined with yellow, or entirely yellow. A pale spot may be present on first genital of female or absent. The underside of thorax is usually pale with a brown band behind each anterior coxa. The abdominal venter embrowned at least along the sides in the female, and brown to black in the male.

*Structural characteristics:* Males with antennae and hind legs modified. The first antennal segment more incrassate than in *R. rileyi.* The antennal formula for the female: 1st: 2nd: 3rd: 4th:: 19: 9: 25: 23. In the male the middle femur is straight, hairless from the base to near the apex where there are a few hairs on inner margin. Middle tibia fringed with long straight hairs on the inner side from base to beyond the middle, then with short straight hairs.

The curved hind femur without long hairs along the inner margin, but with three tufts near the distal end. The hind tibia with a smooth shining depressed area surrounded by hairs as shown in Plate X.

*Location of types:* Not stated in original description.

*Data on distribution:* GEORGIA: The type series taken by J. C. Bradley from Bainbridge, Georgia. TENNESSEE: Knoxville, June 15, 1890. H. E. Summers, reported 1928 by Drake and Harris. MISSISSIPPI: Charleston, Sept. 7, 1925, H. M. Harris. Shipman, Aug. 2, 1921, C. J. Drake.

The above records reported 1928 by Drake and Harris.

We have in the Francis Huntington Snow Museum the following: KANSAS: Cherokee Co., Kans., Aug. 1920. Hungerford and Beamer, 4 ♂ ♂. 1 ♀ (all apterous). OKLAHOMA: Ottawa Co.,

Okla., Cowskin River 9/26/32. L. D. Tuthill, 4 ♂ ♂ (all apterous). Fairland, Okla., 9/24/32. L. D. Tuthill, 79 ♂ ♂, 51 ♀ ♀ (all apterous) and many nymphs. ARKANSAS: Polk Co., Ark., 8/21/28. R. H. Beamer, 10 ♂ ♂ (1 winged), 3 ♀ ♀.

## *Rheumatobates rileyi* Bergroth

Plate XI, fig. 18, Plate XIV, fig. 28.

1891 *Hemipterous larva* Zabriskie, J. L., Jl. N. Y. Microscopical Soc., vol. 7, pp. 128-129 (figured and described an unknown water bug).
1892 *An aquatic Bug* Riley, C. V., Insect Life, vol. IV, pp. 198-200 (refigured and redescribed above under "An Interesting Aquatic Bug").
1892 *Rheumatobates rileyi* Bergroth, E., Insect Life, vol. 4, p. 321 (named above *Rheumatobates rileyi*).
1893 *Rheumatobates rileyi* Riley, C. V., Insect Life, vol. 5, p. 190 (in part) (reports taken by Heidemann from Potomic Canal near Washington).
1895 *Rheumatobates rileyi* Meinert, Fr., Entomologiske Meddelelser, vol. 5, pp. 1-8.
1905 *Rheumatobates rileyi* Torre-Bueno, J. R. de la, Journ. N. Y. Ent. Soc., vol. 13, p. 41 (Echo L., Westfield, N. J., Cranford, N. J.).
1908 *Rheumatobates rileyi* Torre-Bueno, J. R. de la, Journ. N. Y. Ent. Soc., vol. 16, p. 234 (White Plains, N. Y.).
1908 *Rheumatobates rileyi* Bergroth, E., Ohio Nat., vol. 8, p. 381 (records Glen Echo, Md.).
1908 *Rheumatobates rileyi* Torre-Bueno, J. R. de la, Ohio Nat., vol. 9, p. 390.
1909 *Rheumatobates rileyi* Kirkaldy, G. W., and Torre-Bueno, J. R. de la, Catalogue *in* Proc. Ent. Soc., Washington, vol. 10, p. 212.
1910 *Rheumatobates rileyi* Smith, John B., Catalogue of Insects found in New Jersey, 3rd ed., p. 152.
1911 *Rheumatobates rileyi* Torre-Bueno, J. R. de la, Trans. Amer. Ent. Soc., vol. 37, p. 250.
1911 *Rheumatobates rileyi* Torre-Bueno, J. R. de la, Can. Ent., vol. 43, p. 228 (says: *Halobatopsis beginii* Ashm. 1897 is, in part, a synonym).
1912 *Rheumatobates rileyi* Torre-Bueno, J. R. de la, Can. Ent., vol. 44, p. 212 (Yaphank, N. Y.).
1916 *Rheumatobates rileyi* Van Duzee, E. P., Check list of the Hemiptera, p. 49.
1917 *Rheumatobates rileyi* Van Duzee, E. P., Catalogue of the Hemiptera of America North of Mexico, p. 431.
1919 *Rheumatobates rileyi* Hussey, R. F., Water Bugs of Douglas Lake Region *in* Occas. Papers Museum Zool. Univ. of Michigan, no. 75, p. 12 (applies to *R. rileyi palosi* Blatchley).
1920 *Rheumatobates rileyi* Hungerford, H. B., Kansas Univ. Sci. Bull., vol. 11, p. 115 and p. 120 (found in muddy ponds in Kansas and applies to *R. r. palosi* Blatchley).
1920 *Rheumatobates rileyi* Parshley, H. M., Bull. Brooklyn Ent. Soc., vol. 15, pp. 67-70 (reports Mass. as record and says Bueno's citation of *Halobatopsis beginii* Ashmead as synonym not justified).
1920 *Rheumatobates rileyi* Parshley, H. M., Psyche, vol. 27, p. 143 (reports southern Vermont on quiet pond and says color variation is great, some Vermont specimens being dark like Hussey's Michigan specimens).
1922 *Rheumatobates rileyi* Parshley, H. M., Can. Ent., vol. 53, p. 239.
1922 *Rheumatobates rileyi* Parshley, H. M., Bull. Brooklyn Ent. Soc., vol. 17, pp. 136-137 (note on migration).
1922 *Rheumatobates rileyi* Osborn, Herbert, and Drake, Carl J., Tech. Publ., no. 16 of New York State College of Forestry at Syracuse U., p. 82.
1923 *Rheumatobates rileyi* Torre-Bueno, J. R. de la, Connecticut Geol. and Nat. Hist. Survey Bull., 34, p. 663.

1923 *Rheumatobates rileyi* Wiley, Grace Olive, Can. Ent., vol. 55, p. 202, fig. 7 (comp. note).
1925 *Rheumatobates rileyi* Hungerford, H. B., and Beamer, R. H., Ent. News, vol. 36, p. 264 (applies to *R. r. palosi*).
1926 *Rheumatobates rileyi* Blatchley, W. S., Heteroptera of Eastern North America, pp. 982-983 (lists Brooklyn, N. Y., Cranford, N. J., and Raleigh, N. C., but his figure 196 is *R. tenuipes* Meinert not *R. rileyi*). He also describes *R. rileyi palosi* var. nov. from Marion Co., Ind., and Palos Park, Ill.
1926 *Rheumatobates rileyi* Esaki, T., Annales Musei Nationalis Hungarici, vol. 23, pp. 148-149.
1928 *Rheumatobates rileyi* Torre-Bueno, J. R. de la, *in* "A List of the Insects of New York," p. 136, Cornell Univ. Agri. Exp. Sta. Memoir 101.
1928 *Rheumatobates rileyi* Drake, C. J., and Harris, H. M., Ohio Journ. Sci., vol. 28, no. 5, p. 274 (lists Miss., Fla., Ohio, Iowa, Ill.).
1931 *Rheumatobates rileyi* Silvey, J. K., Gwynn Pap. Michigan Acad. Sci. Arts and Letters, vol. 13, pp. 433-446 (life history refers to *R. r. palosi* Blatch.).
1931 *Rheumatobates rileyi* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, p. 67 (says dist. limited, Atlantic Coast to D. C.).
1936 *Rheumatobates rileyi* Deay, Howard O., and Gould, George E., America Midland Naturalist, vol. 17, No. 4, p. 765.
1938 *Rheumatobates rileyi* Beier, Max, Handbuck der Zoologie, vol. 4, p. 2058, fig. 2246.
1942 *Rheumatobates rileyi* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402.
1950 *Rheumatobates rileyi* Moore, A. G., Contrib. de l'Inst. de Biol. Univ. Montreal, no. 26, p. 25.
1950 *Rheumatobates rileyi* Herring, Jon L., Florida Ent., vol. 33, no. 1, p. 31 (records Alachua and Dixie Cos. Florida).
1951 *Rheumatobates rileyi* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc., Washington, vol. 64, p. 155 (report that occurs with var. *palosi* Blatch.). If true the latter is a good species.

*Size:* Length apterous male 2.2 mm to 2.5 mm. Winged male 3.7 mm; apterous female 2.64 mm to 3.15 mm; winged female 3.65 mm.

*Color:* Schroeder 1931 called attention to the variation in color patterns encountered within a species of *Rheumatobates*. This species is quite variable. The size of the pale pronotal spot varies from a small quadrate spot to a broad band. The pale mesonotal spot on the apterous forms may be diamond-shaped and broader than long or it may be entirely lacking as it is in all but one specimen in a series of nine from Quebec, Canada. There is a pale spot above the mesoacetabula in both winged and apterous.

The mesosternum pale, sometimes the anterior margin brown.

*Structural characteristics:* The males with both antennae and hind legs modified. The spur on the terminal antennal segment at or beyond the middle. The antennal formula for the female: 1st: 2nd: 3rd: 4th:: 17: 64: 22: 19. The hind femur of male slightly stouter and hind tibia shorter than in *R. rileyi palosi*. The hind tibia with a slightly raised spot covered with a dense cluster of hairs that is lacking in *R. rileyi palosi*.

*Location of types:* Since this species was named as a new genus and species by Bergroth by indication and reference to Riley's description and figure of 1892 and Riley's work was based upon a slide furnished him by Reverend Zabriskie, this slide should be found and labeled the "type." I understand that Zabriskie's collections are at the American Museum of Natural History. Whether Riley ever returned the slide to Zabriskie I do not know.

If it cannot be found then a male from the Heidemann material taken at Potomac Canal near Washington could be designated taking care to choose *R. rileyi* not *R. tenuipes.*

*Data on distribution:* NEW YORK: Flatbush, Long Island, described without name. We have in our collection: Ithaca, N. Y., July 27, 1894, 1 ♂, 2 ♀ ♀ (apterous). DISTRICT OF COLUMBIA: Potomac Canal near Washington taken by Heidemann. MARYLAND: Glen Echo reported by Bergroth, 1908. We have in our Kirkaldy collection the following from this same series: Glen Echo, Md., 2/10/92. O. Heidemann Collector, ♂ and ♀ (apterous); 3/10/92. O. Heidemann collector, 1 ♀ and 1 nymph; 28/7/93, O. Heidemann Collector, 1 ♂ (apterous); 7/8/93. O. Heidemann Collector, 5 ♂, 1 ♀ (apterous); 9/8/93. O. Heidemann Collector, 1 ♂ (apterous); 16/7/94. O. Heidemann Collector, 1 ♀ (winged).

We also have the following: S. riv. 4 miles S. Annapolis, Md., 7/31/32. P. W. Oman, 6 ♂ ♂, 15 ♀ ♀ (apterous); Annapolis, Md., 8/14/32. Oman and Anderson, 5 ♂ ♂, 4 ♀ ♀ (apterous), 10 nymphs (all on salt or brackish water). NEW JERSEY: Echo L. Westfield, N. J., 2, IX, .04, reported by Bueno, 1905, 5 ♂ ♂, 5 ♀ ♀ (Bueno Coll. at K. U.). Cranford, N. J., reported by Bueno, 1905. Rahway R. Cranford, 20, VIII, 04, N. J., reported by Bueno, 1905, 1 ♂, 4 ♀ ♀ (Bueno Coll. at K. U.). VERMONT: Reported by Parshley, 1920. NORTH CAROLINA: Report from Raleigh, N. C. by Blatchley, 1926. OHIO: Reported by Drake and Harris, 1928. INDIANA: Decatur and Ripley Cos., reported by Deay and Gould, 1936. ILLINOIS: Reported by Drake and Harris, 1928. IOWA: Reported by Drake and Harris, 1928. TENNESSEE: We have in the Francis Huntington Snow Museum the following new state records: Coal Creek, Tenn., 8/27/30. Paul W. Oman, 14 ♂ ♂, 22 ♀ ♀ (apterous); Coal Creek, Tenn., 8/27/30. J. Nottingham, 3 ♂ ♂, 12 ♀ ♀ (apterous); Clarksville, Tenn., July 15, 1939. E. G. Wegenek, 1 ♂, 5 ♀ ♀ (apterous.) MISSISSIPPI: Reported by Drake and Harris, 1928. GEORGIA: The Francis Huntington Snow Museum contains the following new state record: Macon, Georgia, 7/25/30. Paul W. Oman,

1 ♂, 3 ♀ ♀ (apterous and many nymphs). FLORIDA: Reported by Drake and Harris, 1928, also by Herring, 1950. CANADA: Quebec, Can., Beattie Lake, 8/6/49. Jas. Blain, 3 ♂ ♂, 3 ♀ ♀ (apterous); Quebec, Can., Beattie Lake, 8/5/49. Howard Loeb, 3 ♀ ♀ (apterous). This appears to be a new record for Canada.

### *Rheumatobates rileyi palosi* Blatchley

Plate XI, fig. 19; Plate XIV, fig. 29

1919 *Rheumatobates rileyi* Hussey, R. F., Water Bugs of Douglas Lake Region, Occas. Papers Mus. Zool., Univ. of Mich., no. 75, p. 12.
1920 *Rheumatobates rileyi* Hungerford, H. B., Kansas Univ. Sci. Bull., vol. XI, p. 115.
1925 *Rheumatobates rileyi* Hungerford, H. B., and Beamer, R. H., Ent. News, vol. 36, p. 264.
1926 *Rheumatobates rileyi palosi* Blatchley, W. S., Heteroptera or True Bugs of Eastern North America, p. 982 and 984 (desc. from Marion Co., Ind., and Palos Park, Ill.).
1931 *Rheumatobates rileyi* Silvey, J. K. Gwynn, Pap. Michigan Acad. Sci., Arts and Letters, vol. 13, pp. 433-446 (life history).
1931 *Rheumatobates rileyi palosi* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, no. 2, p. 68 and 85, Pl. XI, figs. 1 and 2.
1936 *Rheumatobates rileyi palosi* Deay, Howard O., and Gould, George E., Amer. Midland Nat., vol. 18, no. 4, p. 762, figs. 2 and 16 (records 14 counties but not Decatur and Riply Counties in which they took *R. rileyi rileyi* Bergroth).
1942 *Rheumatobates rileyi palosi* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402.
1951 *Rheumatobates rileyi palosi* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc., Washington, vol. 64, p. 155 (lists as with typical form).

*Size:* Length apterous male 2.27 mm to 2.94 mm, a winged male from Kansas 3.57 mm; of apterous female 2.64 mm to 3.36 mm; have no females with unbroken wings. The subspecies averages a little larger than *R. rileyi rileyi.*

*Color:* Variable. I have not seen a specimen from Cheboygan Co., Mich., showing more than a trace of a pale spot on mesonotum, yet in the series from Rochester, Minn. some have a fair-sized spot, some have none. From Reel Foot Lake, Tenn. most specimens lack the spot as do those from Hilliard, Florida. Material from Kansas and Arkansas usually have a large spot but a few lack it entirely.

*Structural characteristics:* The males with both antennae and hind legs modified. The spur on the terminal antennal segment before the middle. The antennal formula for the female: 1st: 2nd: 3rd: 4th:: 18: 8: 25: 24. The hind femur more slender and hind tibia of male longer than in *R. rileyi rileyi.*

*Location of type:* In the Blatchley Collection at Indiana State College, Purdue, Indiana.

*Data on distribution:* described from Marion Co., Indiana and

Palos Park, Ill. INDIANA: Reported by Deay and Gould from 14 counties. We have: Kosciusko Co., Ind., Oct. 17, 1932. George Gould, 1 ♂, 1 ♀. Kosciusko Co., Ind., July 4, 1932. George Gould, 1 ♂, 1 ♀. ILLINOIS: We have: Piatt Co., Ill., IX/25/32. George Gould, 1 ♂, 1 ♀. OHIO: We have: Paulding Co., Ohio, Aug. 14, 1932. George Gould, 1 ♂. MICHIGAN: We have: From Bessey Creek, Douglas Lake, Mich. From July 18th through Aug. From 1923-1952. H. B. Hungerford, 93 ♂ ♂, 129 ♀ ♀. From Colonial Pt., Burt Lake, Mich., Aug. 5, 1924. H. B. Hungerford, 12 ♂ ♂, 1 ♀. MINNESOTA: Rochester, Minn., July 16, 1921. H. B. Hungerford, 8 ♂ ♂, 8 ♀ ♀. (1 ♀ winged.) KANSAS: Douglas Co., Kans., C. P. Alexander, 23 ♂ ♂, 2 ♀ ♀. (1 ♂ winged.) Dykeman's Bridge, July 1922. H. B. Hungerford, 12 ♂ ♂, 14 ♀ ♀. (1 ♀ winged.) Douglas Co., July 9, 1920. W. E. Hoffmann, 1 ♂, 4 ♀ ♀. Doniphan Co., July 20, 1924. R. H. Beamer, 1 ♂. Montgomery Co., Elk City, 1927. H. B. Hungerford, 2 ♂ ♂, 6 ♀ ♀. Riley Co., Aug. 3, J. B. Norton, 10 ♂ ♂, 3 ♀ ♀. Riley Co., Manhattan, Sept. 13, 1923. H. B. Hungerford, 4 ♂ ♂, 14 ♀ ♀. Scott Co., Aug. 22, 1928. R. H. Beamer, 1 ♂ (winged), 2 ♀ ♀. Hodgeman Co., July 17, 1917, 10 ♂ ♂, 10 ♀ ♀. Cherokee Co., Aug. 15, 1920. Hungerford and Beamer, 15 ♂ ♂, (2 winged) 2 ♀ ♀. OKLAHOMA: Arbuckle Mts., Davis, Okla., July 1925. R. H. Beamer, 1 ♀. Fairland, Okla., 9/24/1932. L. D. Tuthill, 2 ♂ ♂, 1 ♀. TEXAS: Bowie Co., Texas, VIII/16/1928. R. H. Beamer, 3 ♂ ♂, 2 ♀ ♀, and VIII/20/1938. Beamer and Shaw, 3 ♀ ♀. ARKANSAS: Carroll Co., Ark., 9/17/1932. George Gould, 2 ♂ ♂. Polk Co., Ark., 8/21/1928. R. H. Beamer, 5 ♂ ♂, 4 ♀ ♀. TENNESSEE: Reel Foot Lake, Tenn., 1941. Lucile Rice, 8 ♂ ♂, 5 ♀ ♀. LOUISIANA: Beauregard, La., 8/16/1928. J. G. Shaw, 2 ♀ ♀. GEORGIA: Okefenokee Swamp, Georgia, 7/30/34. Beamer and McKinstry, 2 ♀ ♀. FLORIDA: Plant City, Fla., 8/15/30. Paul W. Oman, 1 ♂. Hilliard, Fla., 8/31/30. Paul W. Oman, 6 ♂ ♂, 4 ♀ ♀, 12 nymphs. VIRGINIA: Lake Drummond, Va., 9/10/33. L. D. Anderson, 2 ♂ ♂. Brunswick, Va., Sept. 15, 1929. G. E. Gould, 2 ♀ ♀. Norfolk, Va., VIII/11-13/1934. P. McKinstry, 1 ♂, 1 ♀, and IX/28/1928. George Gould, 1 ♂, 1 ♀.

Determinations based on females alone are questionable. While both *R. rileyi rileyi* and *R. rileyi palosi* are found in Indiana, Illinois, Tennessee, and perhaps Florida, I have not found them from the same place. Should they be so found we must look for intermediates and see what we can learn by breeding experiments.

*Rheumatobates spinosus* sp. nov.

Plate XI, figs. 17 and 17a.

*Size:* Length of apterous male 1.785 mm; width of head .63 mm; greatest width of body .945 mm.

*Color:* Black with abdominal dorsum frosted, a pale spot on the pronotum, eyes reddish, margined by brown bands on vertex; beak and antennae infuscated; venter, except the prosternum dark and somewhat frosted. Basal end of first antennal segment, coxae, trochanters, and genital segments pale.

*Structural characteristics:* Since this unique species is represented by a single damaged male specimen it is impossible to give a complete description. It lacks one antenna, the front and middle legs are gone and only the coxa, trochanter, and basal part of the femur of the left hind leg remain. Yet the antenna and the posterior trochanter are sufficient to recognize this specimen as a new species. The antenna is slightly modified as shown in the drawing.

The segmental formula, 1st: 2nd: 3rd: 4th:: 45: 16: 33: 28. First segment stout, but not incrassate; first and second segments thicker than the others, third segment thin and somewhat curved, fourth segment a little broader, curved with a strong spine near its base. Middle coxae considerably thicker than hind coxae, hind coxae smaller than hind trochanter which is elongate with a conspicuous elongate projection near its base. Hind femur slightly curved with a dense row of hair on inner basal margin. Abdominal venter flat, not hairy, the last segment about as long as the two preceding segments and nearly as long as the first genital segment. In dorsal view the first genital as long as the last two abdominal segments, nearly cylindrical, slightly tapering and somewhat laterally compressed, not hairy.

*Location of type:* Holotype male in the Francis Huntington Snow Museum, University of Kansas. Described from one specimen labeled "Brazil, S. A. Sept. 1935. A. M. Olalla. Rio Parú, Castanha Region."

*Comparative notes:* This species stands quite alone. It runs in my key to the section having modified hind legs in the male with the trochanter enlarged, but the very long basal spur separates it at once from *R. klagei, R. crassifemur,* etc.

## *Rheumatobates klagei* Schroeder

Plate XII, fig. 20.

1931 *Rheumatobates klagei* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, no. 2, p. 75-77; pl. VII, figs. 1-2; pl. VIII, figs. 2 and 5; pl. XI, figs. 7 and 8 (desc. from Amazonas, Brazil).
1942 *Rheumatobates klagei* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402.
1952 *Rheumatobates klagei* Drake, C. J., and Harris, H. M., Proc. Biol. Soc. Washington, vol. 64, p. 155.

*Size:* Length of apterous male 2.27 mm-2.52 mm; of apterous female 2.8 mm to 3 mm; of winged male 3.6 mm; of winged female 3.36 mm.

*Color:* Although described as "dark velvety brown," this species is typically black. The head black with a fulvous U-shaped band on vertex. The pale spot on the pronotum is the only one always present. The mesonotum black often more or less frosted; no pale spot above mesoacetabula; genital segments may be pale or black. Base of antennae and of legs pale. Venter brown to black.

*Structural characteristics:* The antennae and hind legs of male modified. The male antenna with basal segment as long as the head including the tylus, more slender than anterior femur and unarmed; second segment very short, third segment about one and one-half times as long as second; fourth segment as long as the first, curved outward in a regular arc, basal third thin and apical two thirds flattened laterally, apex pointed but not hooked. The female antennal formula: 1st: 2nd: 3rd: 4th:: 23: 8: 20: 30. The female with trochanter and femur of hind leg longer than the tibia and tarsus. The trochanter of hind leg of male with base thickened but not globular as in *R. crassifemur esakii* and lacking the dense hair tuft of *R. c. esakii;* the base of the femur with a dense hair tuft that is lacking in *R. crassifemur* and its subspecies.

*Location of types:* In the Francis Huntington Snow Museum, University of Kansas.

*Data on distribution:* BRASIL: Described from long series of apterous forms bearing the label, [9] "Manacapuru S. A. Amazonas, Brazil, Solimoes River 6-26 S. M. Klages," others with the date 4-26.

Since then we have received the following: Brazil, S. A., Jan.-Apr. 1936, A. M. Olalla, No. 1, R. Amazonas. (Nrte) Region de Itacoatiara 27 ♂ ♂, 36 ♀ ♀ (5 winged). Brasil, S. A., 9-25, 10/12/36. A. M. Olalla, Vic. Santo Antonio River Eiru, No. 3710, 38 ♂ ♂ (9 winged). Brasil, S. A., 9/25, 10/17/36. A. M. Olalla, Vic. Santo Antonio

9. Taken with *R. crassifemur esakii* Schroeder.

River Eiru, No. 3712, 5 ♂ ♂, 2 ♀ ♀. [10] Brasil, S. A., State of Pará; Lago Grande, Feb. 1939. A. M. Olalla, 5 ♂ ♂. [10] Brasil, S. A., 7/10, 9/20/36. A. M. Olalla, Vic. João Pessoa, (São Phelipe) River Jurua, No. 374. 40 ♂ ♂ (13 winged). Brasil, S. A., 7/10, 9/20/36. A. M. Olalla, Vic. João Pessoa, (São Phelipe) River Jurua, No. 372, 2 ♂ ♂.

### *Rheumatobates crassifemur crassifemur* Esaki

Plate XII, fig. 21.

1926 *Rheumatobates crassifemur* Esaki, T., Annales Musei Nationalis Hungarici, vol. 23, p. 149-153, figs. 9a-f (desc. from Argentina and Paraguay).
1931 *Rheumatobates crassifemur* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, no. 2, p. 74-75.
1936 *Rheumatobates crassifemur esakii* Drake, C. J., and Harris, H. M., Proc. Biol. Soc., Washington, vol. 49, p. 108 (det. as *R. crassifemur esakii* Schroeder. Reported from Brazil).
1937 *Rheumatobates crassifemur* Drake, C. J., and Harris, H. M., Rev. de Entomologica, vol. 7, fasc. 4, p. 362 (places their *R. crassifemur esakii* Schroeder from Brazil here).
1942 *Rheumatobates crassifemur* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402.
1951 *Rheumatobates crassifemur* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc., Washington, vol. 64, p. 154, Pl. XIIIb (in litt. Drake says drawing is of *R. esakii* Schroeder. However antenna incorrectly shown).

*Size:* Length of apterous male 2 mm to 2.22 mm; length of apterous female 2.5 mm to 2.86 mm. Winged female 3.28 mm to 3.57 mm. Esaki gives maximum length of female 3 mm and of winged forms 4 mm.

*Color:* Black, more or less frosted. Head black with flavous U shaped band on vertex; pale spot on pronotum; sometimes pale spot on and above mesoacetabula. Base of antennae and of legs usually pale. Venter usually brown to black.

*Structural characteristics:* Antennae and hind legs of male modified. The male antenna with basal segment slightly swollen, about as long as the head; second segment short, about as broad as long, with two long hairs on ventral side; third segment more slender and a little longer than the second, with two stout hairs on inner margin; the fourth segment with basal third slender then becoming broader; at its base a pencil of fused hairs directed laterally; the distal two thirds thickened and curved with a row of spaced hairs dorsally on the curve before the tip. The female antennal formula: 1st: 2nd: 3rd: 4th:: 18: 7: 20: 28. The female with the trochanter and femur of hind leg slightly longer than the tibia and tarsus. The trochanter of the hind leg of male with base thickened and a dense

10. Taken with *R. crassifemur esakii* Schroeder.

tuft of hairs present plus a fringe of hairs. The base of femur without a hair tuft.

*Location of types:* Described from 1 male, 8 females from Posadas, Argentina (June 1900 Silvestri) in the Hungarian National Museum, Budapest. (apterous); two males, three females (Macropterous) and two males and two females. (apterous) from Chaco, Paraguay (Fiebrig), in Natural History Museum, Vienna. I studied the above when in Vienna and Budapest.

*Data on distribution:* ARGENTINA: The type series above. PARAGUAY: The type series above. BOLIVIA: We have in the Francis Huntington Snow Museum the following: R. Mamores, Trinidad III-1938 A. M. Olalla (60 ♂ ♂, 120 ♀ ♀). R. Beni, El Consuelo 1938. A. M. Olalla (41 ♂ ♂, 82 ♀ ♀). R. Beni, Puerto Salinas, XI 1937, A. M. Olalla (5 ♀ ♀). R. Beni, Las Pampas, Mojos, Apr. 1938. A. M. Olalla (4 ♂ ♂). Santa Rosa del Yacuma, II, 1938, A. M. Olalla (1 ♂, 3 ♀ ♀).

### *Rheumatobates crassifemur esakii* Schroeder

Plate XII, fig. 22.

1931 *Rheumatobates crassifemur esakii* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, no. 2, p. 77-78; pl. VII, fig. 3; pl. VIII, figs. 3 and 4 (desc. from Amazonas, Brazil).
1936 *Rheumatobates crassifemur esakii* Drake, C. J., and Harris, H. M., Proc. Biol. Soc., Washington, vol. 49, p. 108 (later 1937 they say these specimens from São Paulo, Brazil, are *R. crassifemur* Esaki not *R. esakii* Schroeder).
1937 *Rheumatobates esakii* Drake, C. J., and Harris, H. M., Rev. de Entomologia, vol. 7, fasc. 4, p. 362 (they raise *R. crassifemur esakii* Schroeder to specific rank).
1942 *Rheumatobates esakii* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402.
1951 *Rheumatobates esakii* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc., Washington, vol. 64, p. 155.

*Size:* Length of apterous male 2.05 mm to 2.39 mm. Length of winged male 3.36 mm to 3.78 mm. Apterous female 2.5 mm to 2.94 mm.

*Color:* Black. Head black with fulvous band on base of vertex. Pale spot on pronotum of variable size. No pale spot above mesoacetabula. Venter brown to black.

*Structural characteristics:* Antennae and hind legs of male modified. The male antenna differs from other subspecies in having basal segment a little more incrassate and the terminal segment recurved with about four of the dorsal hairs, before the curve, large, stout and close together and longer than in any of the others forms. The female antennal formula: 1st: 2nd: 3rd: 4th:: 18: 7: 20: 25.

The female with the trochanter and femur of hind leg subequal to the tibia and tarsus. The trochanter of the hind leg of the male with base thickened and a dense tuft of hairs but lacking the heavy fringe of hairs present in *R. crassifemur crassifemur.* The base of femur without a hair tuft.

*Location of types:* Four males in Francis Huntington Snow Museum.

*Data on distribution:* BRAZIL: Described from "Manacapuru, Amazonas, Solimoes River, VI, 1926. S. M. Klages.

In addition we have in the Francis Huntington Snow Museum the following: [11] Brazil, S. A. Jan.-Apr., 1936, R. Amazonas, Region de Itacoatrora. A. M. Olalla (4 ♂ ♂, 10 ♀ ♀). [11] Brazil, S. A., State of Pará, Lago Grande, Feb. 1939, A. M. Olalla (8 ♂ ♂, 20 ♀ ♀). Brazil, S. A., Utinga, Belen, Para XL-25, 1945 L. Deane (6 ♂ ♂, 2 ♀ ♀). [11] Brasil, S. A., Vic. João Pessoa (São Phelipe) River, Jurua No. 374, VII-10 to IX-20, 1936. A. M. Olalla (46 ♂ ♂). BRITISH GUIANA: Supurini Creek, Aug. 31, 1937, S. Harris (7 ♂ ♂, 5 ♀ ♀.)

### *Rheumatobates crassifemur schroederi* subsp. nov.

Plate XII, fig. 23.

*Size:* Length of apterous male 2.02 mm-2.4 mm; length of apterous female 2.52 mm to 3.15 mm.

*Color:* Black but sometimes entirely frosted over to appear gray. Head brown to black with a fulvous band on vertex. Pronotum with pale spot. No pale spot above the mesoacetabula. Base of antenna and of front femur pale. Sometimes middle and hind trochanters pale. Legs otherwise brown. Venter dark, often frosted.

*Structural characteristics:* Male antennae and hind legs modified. First antennal segment of male moderately incrassate, as thick as the front femur. The dorsal row of bristles on the last antennal segment, quite uniformly spaced and more numerous than in other subspecies. The antennal formula of the female: 1st: 2nd: 3rd: 4th:: 18: 7: 20: 30. The hind trochanter and femur slightly longer than tibia and tarsus in female. The middle femur of the male is incrassate as in other subspecies. The hind trochanter lacks the dense margin of long hairs on the basal lobe that are present in *R. crassifemur crassifemur.* All of the subspecies have the tuft of long hairs on the hind trochanter and lack such a tuft at base of hind femur.

11. Taken with *R. klagei* Schroeder.

*Location of types:* Holotype, allotype and 21 paratypes (9 ♂ ♂, 12 ♀ ♀) in the Francis Huntington Snow Museum, and one pair in Dr. Drake's collection.

*Data on distribution:* BRASIL: The type series bear the label: Logoa Mecejana near Fortaleza, Ceará, Brasil, S. A., June 14, 1936. Stillman Wright, No. 11062. We have, in addition, the following: Acude Pitombeira, 15 km. from Caicó, Rio Grande do Norte, Brasil, S. A., June 1933. S. Wright, No. 343 (6 ♂ ♂, 13 ♀ ♀). Acude Creminosa, Nr. Maranguape, Ceará, Brasil, S. A., Nov. 3, 1937. S. Wright (4 ♂ ♂, 5 ♀ ♀). Pernambuco, Brasil, S. A., Jan. 31, 1935. Revino D. Bento (1 ♂, 3 ♀ ♀).

## *Rheumatobates imitator* (Uhler)

Plate XIII, figs. 25 and 25a; Plate XV, fig. 30.

1894 *Hymenobates imitator* Uhler, P. R., Proc. Zool. Soc. London, 1894, p. 214 (desc. from Grenada).
1908 *Rheumatobates imitator* (Uhler) Bergroth, E., Ohio Nat., vol. 8, No. 8, p. 380 (says *Hymenobates* Uhler is synonym of *Rheumatobates* Bergroth).
1909 *Rheumatobates imitator* Kirkaldy, G. W., and Torre-Bueno, J. R. de la, Catalogue *in* Proc. Ent. Soc., Washington, vol. 10, p. 212.
1930 *Rheumatobates imitator* Wolcott, G. N., Journ. Agri. Univ. Puerto Rico, vol. 20, p. 150.
1931 *Rheumatobates imitator* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, no. 2, p. 69.
1939 *Rheumatobates imitator* Barber, H. G., Insects of Porto Rico and Virgin Islands, Hem.-Het. *in* Scientific Survey of Porto Rico and Virgin Islands, vol. 14, pt. 3, p. 407 (New York Acad. Sci.). (Sent sketch of Porto Rican specimen to Dr. China who compared it with Uhler's type.)
1942 *Rheumatobates imitator* Drake, C. J., and Harris, H. M., Rev. Brazil Biol., 2(4), p. 401 (records Porto Rico; Trinidad, B. W. I.; St. Crois, Virgin Isl.).
1944 *Rheumatobates imitator* Drake, C. J., and Harris, H. M., Rev. de Entomologia, vol. 15, fasc. 3, p. 272, text fig. 2 of winged female, apterous male.
1948 *Rheumatobates imitator* Hynes, H. B. N., Trans. R. Ent. Soc., London, vol. 99, p. 347 (collected in Trinidad, B. W. I.).

*Size:* Length of apterous male 2.31 mm to 2.6 mm; length of apterous female 2.73 mm to 2.94 mm. Winged male 3.75 mm.

*Color:* Brownish black to black, somewhat frosted. Pale quadrate spot on pronotum often broader than long. A large more or less diamond-shaped spot on mesonotum. A pale spot above the mesoacetabula often fused with the pale mesoacetabula. Base of vertex fulvous. Thoracic venter pale; abdominal venter may be brown to black in males. Base of antennae, front femora, coxae and trochanters of all legs may be pale; hind trochanter of male usually brown to black as are the middle and hind legs in both sexes.

*Structural characteristics:* Male antennae and hind legs modified. First antennal segment of male a little longer than the head, basal two thirds slightly swollen and fringed within with long hairs. The

antennal formula of female: 1st: 2nd: 3rd: 4th:: 18: 8: 24: 18. The hind trochanter and femur shorter than tibia and tarsus in female. Middle tibia of the male strongly sinuate; hind trochanter not greatly enlarged, provided with tufts of long hairs, but no toothlike protuberence on dorsomedial margin; femur with a pendiculate stem bearing a T- or anchor-shaped structure on its inner margin. (Compare with *R. mexicanus* Drake and Hottes.)

*Location of types:* In British Museum.

*Data on distribution:* GRENADA: Type series "South of Grenville, windward side of island Aug. 4th, on stagnant water. Only one specimen of the winged form is present in the collection. The others are either young specimens, or underdeveloped females without indications of wings. The measurements are taken only from the winged male specimen used for description. The females have the simple antennae and hind legs as in *Rheumatobates* Bergr. and *Metrobates* Uhler. In the female, however, the antennae are very much shorter than in either of the genera just mentioned." PORTO RICO: Recorded by Wolcott 1930, Barber 1939, Drake and Harris, 1942.

We have in the Francis Huntington Snow Museum the following: Mayaguez, Puerto Rico, Aug. 4, 1935. H. D. Tate, 2 ♀ ♀. Mayaguez, Puerto Rico, April 1935, ♀ and ♂. Quebrada, Tomey, VII/11/1935. Needham and Diaz, 3 ♂ ♂. TRINIDAD: Reported by Drake and Harris 1942 and Hynes 1948.

We have from Trinidad, B. W. I., Oct. 27, 29, 1938. Carl J. Drake, 1 ♂. VIRGIN ISLANDS: Reported from St. Croix by Drake and Harris 1942.

### *Rheumatobates bergrothi* Meinert

Plate XIII, figs. 24, 24a; Plate XV, fig. 31.

1895 *Rheumatobates bergrothi* Meinert, Fr., Entomologiske Meddelelser, vol. 5, pp. 1-8, tab. I and II.

1908 *Rheumatobates bergrothi* Bergroth, E., Ohio Nat., vol. 8, no. 8, p. 380 (lists as apterous form of *Hymenobatis imitator*, Uhler in error).

1909 *Rheumatobates bergrothi* Kirkaldy, G. W., and Torre-Bueno, J. R., Catalogue *in* Proc. Ent. Soc., Washington, vol. 10, p. 212 (lists as synonym of *R. imitator* Uhler).

1931 *Rheumatobates bergrothi* Schroeder, Herman O., Univ. of Kansas Sci. Bull., vol. 20, no. 2, p. 69 (cites as synonym of *R. imitator* Uhler).

1939 *Rheumatobates bergrothi* Barber, H. G., Insects of Porto Rico and the Virgin Islands, Hem.-Het. in Scientific Survey of Porto Rico and the Virgin Islands, vol. 14, pt. 3, p. 407 (N. Y. Acad. Sci. lists Jamaica and Haiti which Drake and Harris 1942 say apply to *R. meinerti* Schroeder).

1942 *Rheumatobates bergrothi* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 399-400 (report from Panamá).

1951 *Rheumatobates bergrothi* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc., Washington, vol. 64, p. 154 (record Panamá, V. I., and Grenada and say *R. bergrothi* Barber 1939 is syn. of *R. imitator* Uhler).

*Size:* Length of apterous male 2.3 mm to 2.94 mm; of apterous female 2.64 mm to 3.46 mm. Winged female 3.36 mm.

*Color:* Black. Head black, sometimes a narrow fulvous line at base of vertex. Pronotal pale spot broader than long. Mesonotal spot, more or less triangular, smaller than pronotal spot, occasionally absent. Small pale spot above mesoacetabula. Base of antenna, base of front femur, all coxae usually pale, legs otherwise brown to black. Thoracic venter usually pale, the abdominal venter of male more or less embrowned.

*Structural characteristics:* Male antennae and hind legs modified. First antennal segment of male a little longer than the head, basal two thirds somewhat thickened; the padlike concavity of the third segment occupying the distal half; the distal half of last segment stoutly serrated on inner margin. The antennal formula for the female: 1st: 2nd: 3rd: 4th:: 20: 8: 28: 19. Hind trochanter and femur shorter than the tibia and tarsus in female. Middle tibia of male slightly sinuate; hind trochanter greatly incrassate with a black protuberence the lateral tooth of which is quite long and sharp; the T shaped structure on the inner margin of hind femur with a straight pedicel, the caudal arm of the T, a broad thin plate. I examined the types in Copenhagen in 1928 and have before me a paratype thanks to the kindness of Prof. Sparck and Dr. Sv. G. Larson. Meinert's drawing of this structure was incorrect.

*Location of types:* In the Universitetets Zoologiske Museum, Cobenhavn, Denmark.

*Data on distribution:* GRENADA: The type series taken by Meinert in a little stream north of George Town between the 13th and 25th of May 1891. VENEZUELA: Turiamo Aragua, XI/4/1951. Wm. H. Wells, 7 ♂ ♂, 28 ♀ ♀ (1 winged.) This is a new record. PANAMA, (Canal Zone) Fort Clayton, C. Z., 11/11/1932. Capt. R. F. Edwards, 15 ♂ ♂, 40 ♀ ♀ and some nymphs. Reported from Panamá by Drake and Harris, 1942.

### *Rheumatobates meinerti* Schroeder

Plate XIII, figs. 26, 26a; Plate XV, fig. 32.

1931 *Rheumatobates imitator* var. *meinerti* Schroeder, Herman O., Kansas Univ. Sci. Bull., vol. 20, no. 2, p. 70-71, pl. VI, figs. 1 and 2; pl. VIII, fig. 1 (desc. as *R. imitator* var *meinerti* from Haiti).

1939 *Rheumatobates bergrothi* Barber, H. G., Insects of Porto Rico and Virgin Islands. Hem. and Het. in Scientific Survey of Porto Rico and Virgin Islands, vol. 14, pt. 3, p. 407 (records as *R. bergrothi* Meinert specimens from Haiti and Jamaica).

1942 *Rheumatobates meinerti* Drake, C. J., and Harris, H. M., Rev. Brasil Biol., 2(4), p. 402 (say Barber's *R. bergrothi* from Haiti and Jamaica are *R. meinerti* which they give specific rank).
1952 *Rheumatobates meinerti* Drake, C. J., and Hottes, F. C., Proc. Biol. Soc., Washington, vol. 64, p. 155 (here lists only Haiti).

*Size:* Length of apterous male 2.52 mm; of apterous female 3.06 mm.

*Color:* Brownish black to black. Pale spot on pronotum broader than long. Mesonotal spot somewhat diamond shaped, variable in size and doubtless absent in some specimens. Pale spot above mesoacetabula. Base of antennae, front femora, all coxae more or less pale. Trochanters of middle legs of male and of both middle and hind legs of female pale; legs otherwise dark. Thoracic venter mostly pale, abdominal venter of males may be embrowned.

*Structural characteristics:* Male antennae and hind legs modified. The first antennal segment of the male a little longer than the head, its basal two-thirds about as thick as the front femur. The antennal formula of the female cannot be determined because antennae are broken off in both females available. The straight middle tibia of the male which lacks the long hairs and sinuate shape of *R. bergrothi* identifies this species.

*Location of types:* In the Francis Huntington Snow Museum, University of Kansas.

*Data on distribution:* HAITI: The type series. Aux Cayes, 14/6/1894. H. Nepperschmidt. Holotype apterous male. Allotype apterous female and paratypes three apterous males, one female.

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## PLATE VII *

1. *Rheumatobates petilus.* Male.
2. *Rheumatobates drakei.* Male.
3. *Rheumatobates bonariensis.* Male.
4. *Rheumatobates minutus.* Male.
5. *Rheumatobates vegatus.* Male.
6. *Rheumatobates clanis.* Male.

6a. Left front femur of male, in posteroventral view. Note that the spine row is double on basal half and the spines appear short because viewed from above them.

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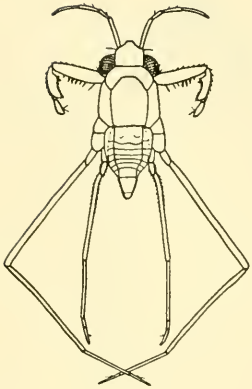
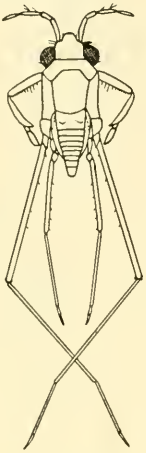
* Drawings on this and following plates made by my research assistant Cheng Liang.

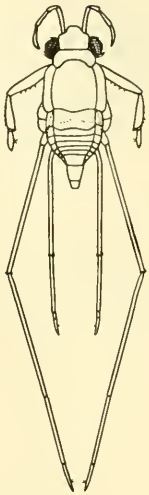
PLATE VII



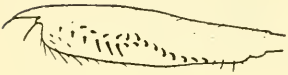
1 R. petilus



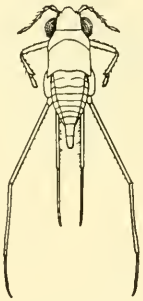
2 R. drakei



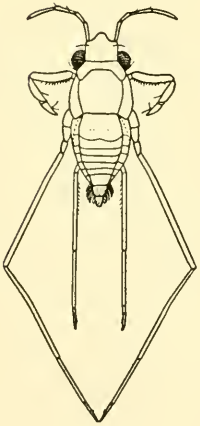
3 R. bonariensis



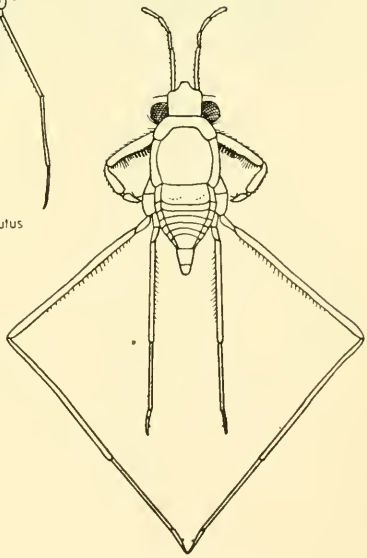
6a.



4 R. minutus



5 R. vegatus

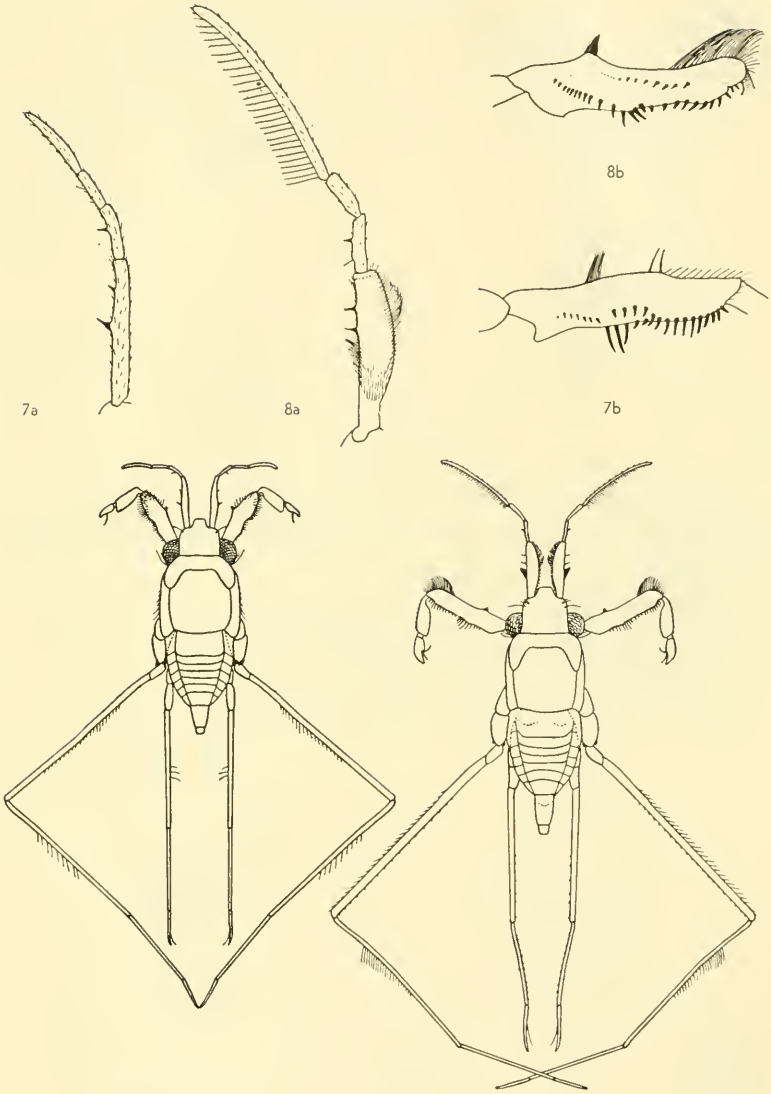


6 R. clanis

## PLATE VIII

7. *Rheumatobates (Hynesia) mangrovensis.* Male.
7a. Ventral view of left antenna of male.
7b. Posteroventral view of front femur of male.
8. *Rheumatobates (Hynesia) trinitatis.* Male.
8a. Ventral view of left antenna of male.
8b. Posteroventral view of front femur of male.

PLATE VIII




7 R (H) mangrovensis

8 R (H) trinitatis

## PLATE IX

9. *Rheumatobates carvalhoi.* Male (redrawn from Drake and Harris).

9a. Under side of abdomen showing the long hairs (hairs not shown on right side of insect).

10. *Rheumatobates creaseri.* Male.

10a. The outside view of the left antenna of a wingless male.

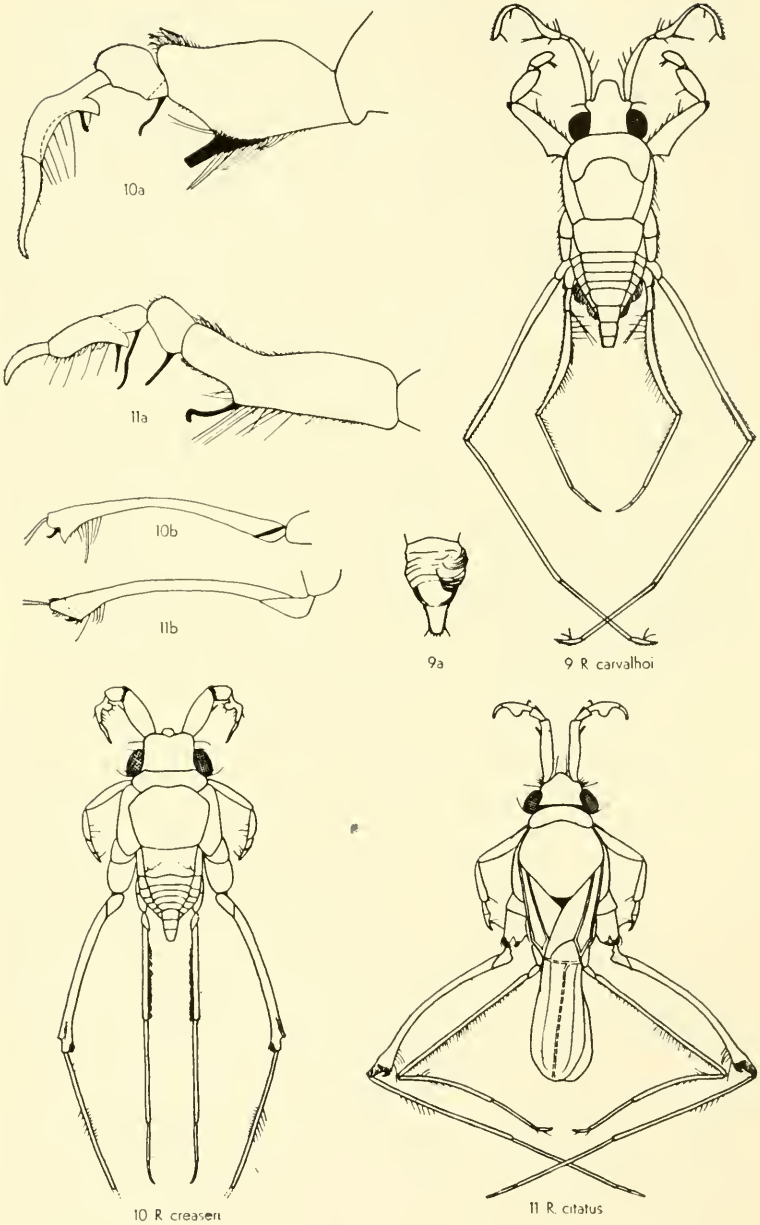
10b. The dorsal view of the left middle femur of male.

11. *Rheumatobates citatus.* Winged male.

11a. The outside view of the left antenna of male.

11b. The dorsal view of the left middle femur of male.

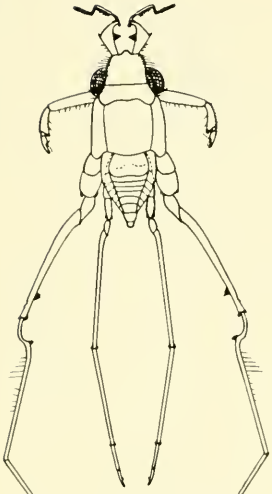
PLATE IX



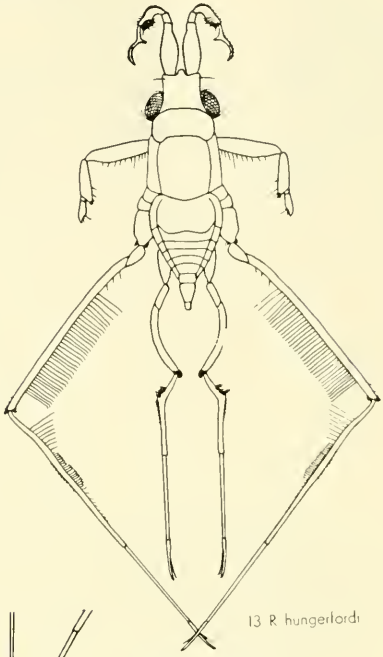
## PLATE X

12. *Rheumatobates praeposterus.* Male.
13. *Rheumatobates hungerfordi.* Male.
14. *Rheumatobates trulliger.* Male.
15. *Rheumatobates tenuipes.* Male.
15a. Middle and hind tarsi of 15.

PLATE X

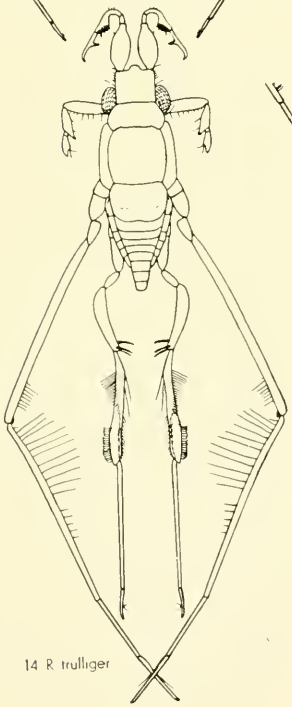


12 R praeposterus

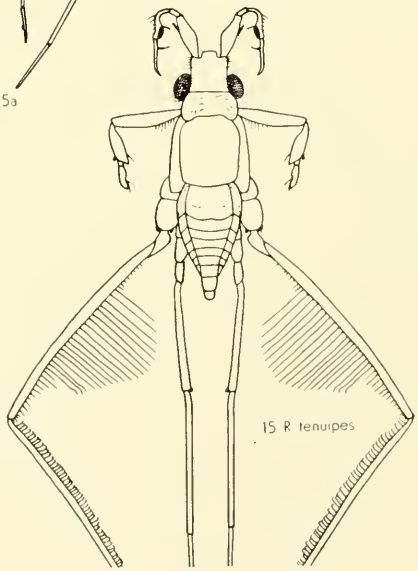


13 R hungerfordi

15a



14 R trulliger

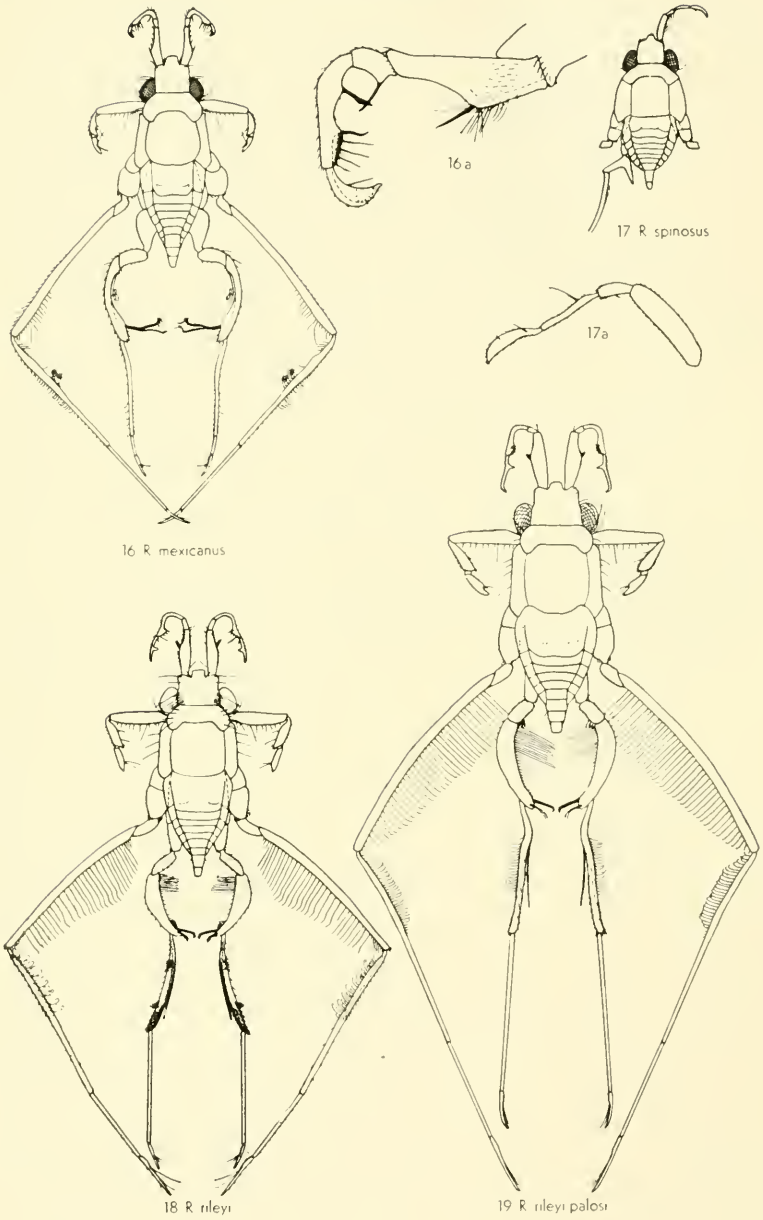


15 R tenuipes

## PLATE XI

16. *Rheumatobates mexicanus.* Male.
16a. Left antenna—outside view.
17. *Rheumatobates spinosus.* Male.
17a. The ventral view of the right antenna of male.
18. *Rheumatobates rileyi.* Male.
19. *Rheumatobates rileyi palosi.* Male.

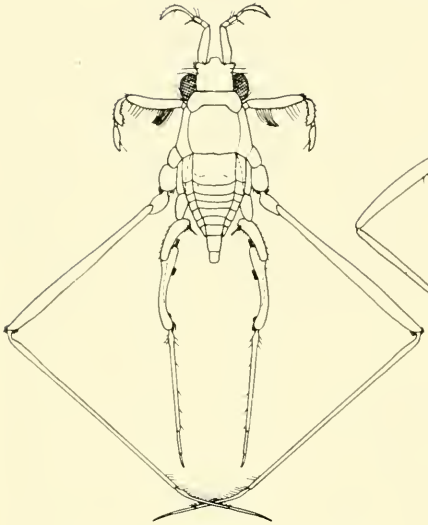
PLATE XI


16 a
17 R spinosus
17a
16 R mexicanus
18 R rileyi
19 R rileyi palosi

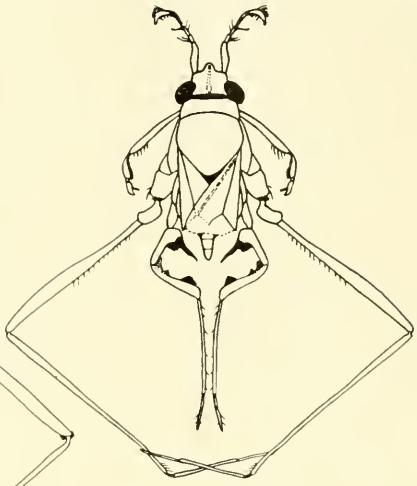
## PLATE XII

20. *Rheumatobates klagei.* Male.
21. *Rheumatobates crassifemur.* Male.
22. *Rheumatobates crassifemur esakii.* Male.
23. *Rheumatobates crassifemur schroederi.* Male.

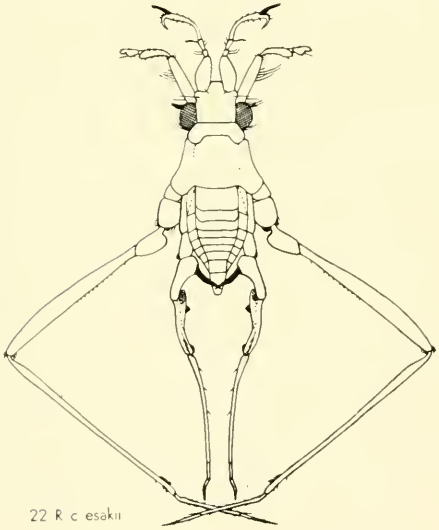
PLATE XII



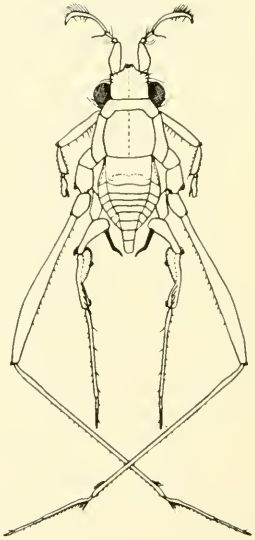
20 R klagei



21 R crassifemur



22 R c esakii

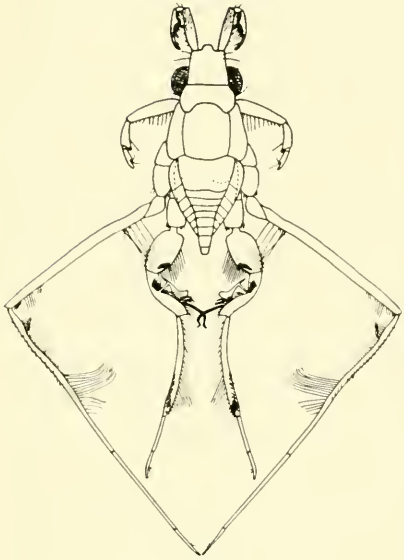


23 R c schroederi

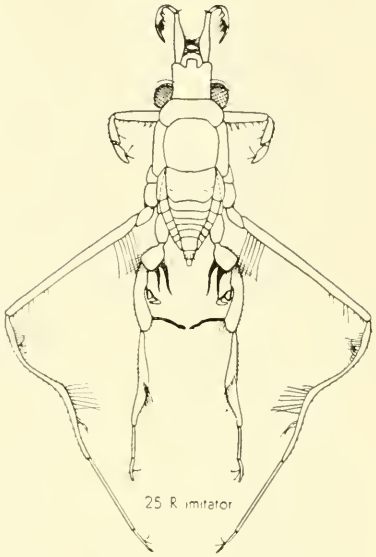
## PLATE XIII

24. *Rheumatobates bergrothi.* Male.
24a. Left antenna of male—outside view.
25. *Rheumatobates imitator* (Uhl.). Male.
26. *Rheumatobates meinerti.* Male.
26a. The outside view of the left antenna of male.

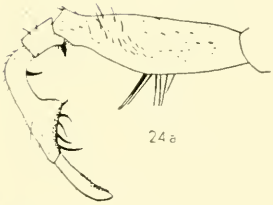
PLATE XIII



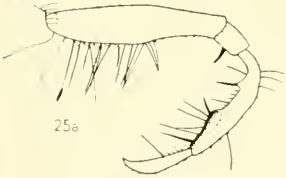
24 R bergrothi



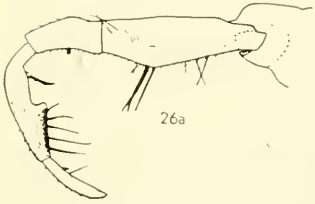
25 R imitator



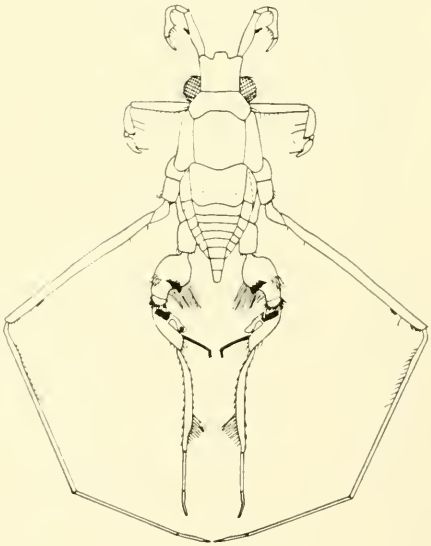
24a



25a



26a



26 R meinerti

## PLATE XIV

27. *Rheumatobates mexicanus.* Right hind leg of male.
28. *Rheumatobates rileyi rileyi.* Right hind leg of male.
29. *Rheumatobates rileyi palosi.* Right hind leg of male.

PLATE XIV

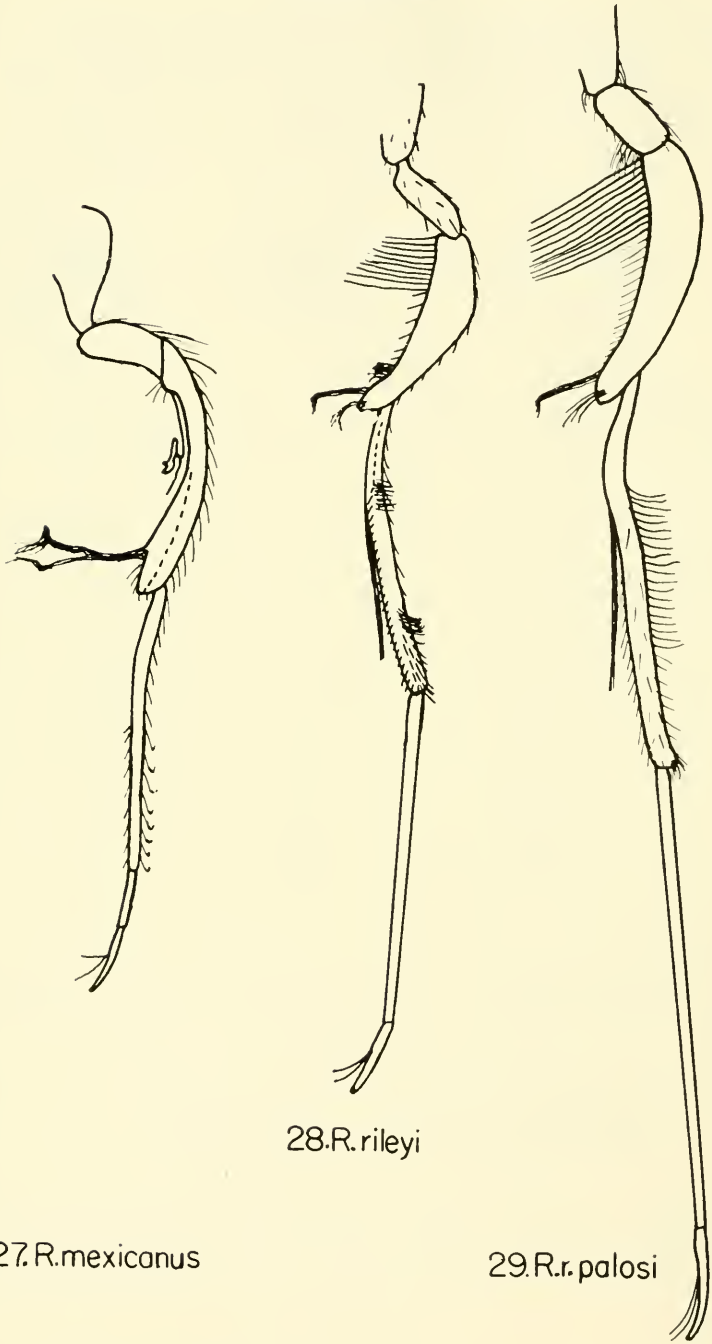


PLATE XV

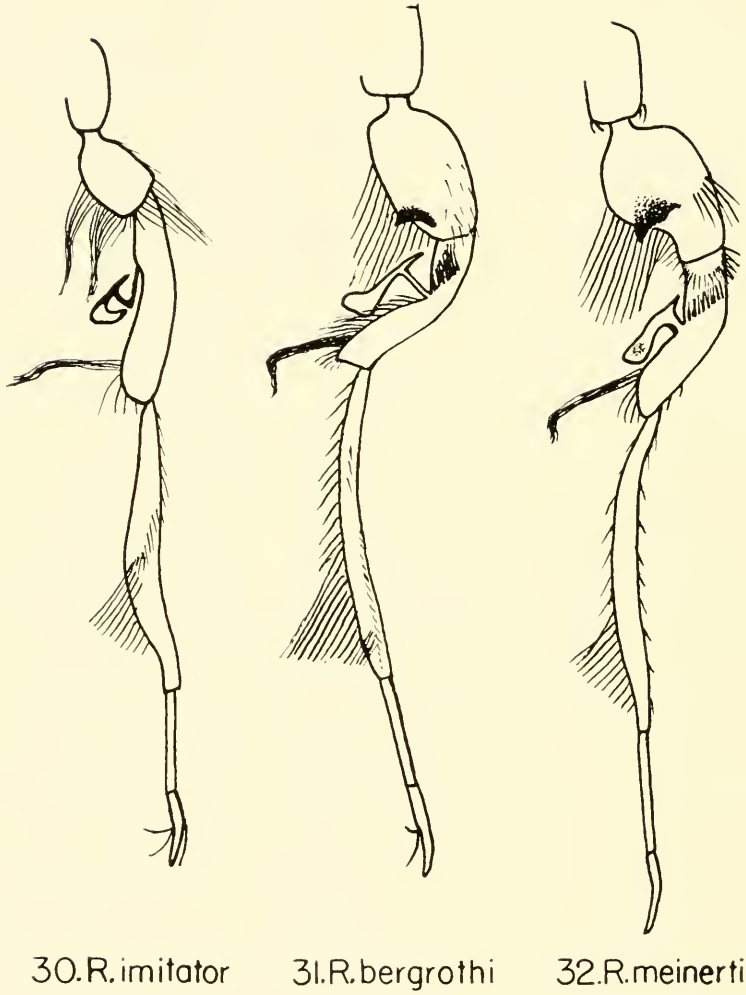



PLATE XV

30. *Rheumatobates imitator.* Right hind leg of male.
31. *Rheumatobates bergrothi.* Right hind leg of male.
32. *Rheumatobates meinerti.* Right hind leg of male.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

Vol. XXXVI, Pt. I] June 1, 1954 [No. 8

# Frog-Egg Eating Tadpoles of *Anotheca coronata* (Stejneger). (Salientia, Hylidae).

BY

Edward H. Taylor

Abstract: Tadpoles of *Anotheca coronata* obtained from bromelias were found to have the upper intestine filled largely with undigested eggs of some species of arboreal frog.

The tadpoles although equipped with a horny beak, ingest the eggs whole. The musculature about the mouth is greatly developed and the intestine unlike that of the typical tadpoles is not coiled, but much expanded and shortened. Labial denticulations are reduced greatly, there being only one complete and one broken series on upper lip, and two series on lower lip.

The species of frog described by Dr. Leonhard Stejneger [1] from Palomo, Valle de Orosi, Cartago Province, Costa Rica, as *Gastrotheca coronata*, was made the type of a new genus *Anotheca* by Dr. Hobart M. Smith.[2] The species was found to be abundant at certain points near Córdoba, Veracruz, Mexico during January, 1938.[3] In Costa Rica, the species has been difficult to find and from the time of its discovery by Dr. C. Picado T. in April 1911 (*fide* Stejneger), no specimen has been reported from that country to my knowledge.[4]

I was fortunate in obtaining two adult specimens of this species in Costa Rica in 1952. One was collected at Moravia de Chirripo by John Baker from low shrubs near a stream, on the night of June 26; the other I obtained from a bromelia, in a felled tree, together with two unusual tadpoles, on June 25, 1952. Three other tadpoles of this type had been found on June 19 in bromelias in another recently

1. Proc. U. S. Nat. Mus., vol. 41, 1911, pp. 287-288.

2. Proc. Biol. Soc. Washington, vol. 52, 1939, pp. 190-191, pl. 1, figs. 1-3 and pl. 2, fig. 6.

3. One was taken Jan. 1; 13, Jan. 3; 43, Jan. 5; 32, Jan. 16.

4. A specimen of frog from Costa Rica, collected by Underwood at Carrillo, Costa Rica, and referred by Günther to the *Nototrema oviferum*, is very young, not yet having completed its metamorphasis. Günther describes it at length and figures the specimen. It seems entirely probable that this is a young *Anotheca coronata* and its discovery antedates that of the type. (See Günther, Biologia Centrali-Americana, Reptilia and Batrachia, Sept. 1901, p. 288, pl. 74, fig. A. (3 figs.).

felled tree, but a large frog also present in the bromelia escaped before its identity could be determined. These arboreal tadpoles were different from most aquatic forms in general conformation, and their lavender, or purplish coloration strongly suggested that they belonged to *Anotheca coronata,* present in the bromelias, since the same colors predominate in the adults of that species.

In the small quantity of water in the bromelias where the tadpoles were taken, there were floating eggs of some frog, which I suspected were those of another species. The tadpoles were semitransparent and the eggs with which their bodies were stuffed, were easily visible, and had been so recently engulfed, that they showed no sign of disintegration. The tadpoles, taken on the 19th some days before, were in water in which no eggs were present, but these too contained many eggs, seemingly recently engulfed. On casual observation they suggested a neotenic tadpole about ready to deposit eggs.

This habit of taking whole frog eggs for food by tadpoles is a somewhat rare occurrence but it has been reported in arboreal frogs of the families Microhylidae and Hylidae. Noble[5] gives an excellent account of this habit in his study on the tadpoles of *Hoplophryne* and *Staurois.*

It would appear that frog eggs are the main article of diet of these arboreal tadpoles but it is still uncertain whether they prey on the eggs of their own species, or on those of other species. All of the larger specimens have the stomachs crammed with new-laid eggs. Even the smallest one, measuring 12.1 mm. in total length, contains 10 eggs any one of which has a diameter equal or greater than the width of its mouth.

The behavior of the tadpoles when first discerned was that of attempted escape and they hid at the base of the leaves of the bromelia. I could not discern that they were more or less active than stream or pond tadpoles. Nor could I determine the reason for the highly developed musculature of the jaws.

Since the eggs seemingly are sucked into the mouth, and not nibbled or cut up by the beak, the muscles must subserve this function at least. Since rains were frequent at the time of my visit the water in the bromelias was not thickened. I did not find gills present in the specimens studied. (See fig. 2B.)

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5. The Adaptive Modifications of Arboreal Tadpoles of Hoplophryne and the Torrent Tadpoles of Staurois. Bull. Amer. Mus. Nat. Hist.; vol. 58, 1929, pp. 291-334, pl. 15-16, figs. 1-10.

I am under obligation to Dr. Grace Orton for certain of the references here given and numerous data of importance to me in this study.

*Description of tadpole:* Body relatively short, plump, its greatest length (11.6 mm.) exceeding its greatest width (10 mm.); a pair of indistinct dorsal ridges run forward to near nostrils, between them a very slight concavity; between eye and nostril there is a slight

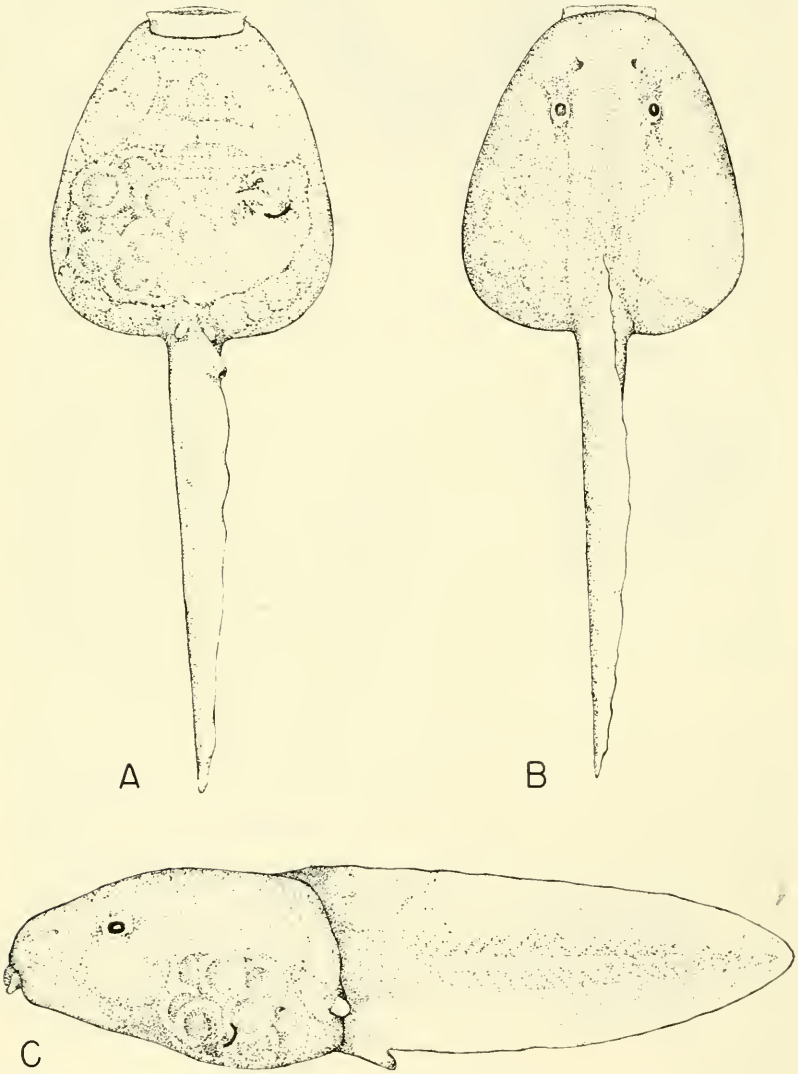


Fig. 1. Tadpole of *Anotheca coronata* (Stejneger). Moravia de Chirripo, Costa Rica. A. Ventral view; B. Dorsal view; C. Lateral view.

lateral elevation; the length of the tail (16 mm.) 2.4 times its greatest depth; musculature of the tail rather strongly compressed laterally, the myotomes more or less distinctly visible; eyes dorsal, moderately large, set wide apart (2.8 mm.), the distance between them less than their distance from anterior level of snout (3.1 mm.); distance between nostrils (2.4 mm.) equal to their distance from anterior level of snout; seemingly a somewhat depressed area lateral to the nostril; dorsal tail fin inserts on posterior part of body and attains its greatest elevation near the base of the tail; it narrows slightly and save where it rounds the tip, maintains approximately the same elevation (approx. 2. mm.).

Vent opens through a short tube, directed dextral; a pair of limb buds visible on each side, .8 mm. in length. Spiracle sinistral, lateral, the opening semilunar in shape, its distance from anterior level of snout 1.5 times its distance from posterior level of body.

Mouth surrounded by a continuous free flap, papillate on its outer edge, upper part slightly less elevated than lower, their edges closely approximated in a straight transverse line (appearing like a pair of lips), concealing from view tooth-rows and beak. On inside of upper lip, there is a single elongate row of denticles, behind which (or below) on each side is a very short, somewhat curved row; on inner side of lower lip are two transverse rows of denticulations, the outer somewhat sinuous, the inner nearly straight. The upper and lower parts of the beak are moderately heavy and denticulations are very fine and numerous, scarcely visible without examination under a lens.

The musculature of the head is conspicuously and strikingly developed. In ventral view the submaxillaries appear as two thick plump muscles touching the anterior end of the ceratohyo-angularis; the subhyoideus is slenderer and somewhat more elongate than the submaxillarius; the geniohyoideus is a thin elongate muscle separated from its fellow by a distance equal to its width. Laterally the musculature is somewhat massive. The temporalis is large and partly overlain by the eye. Below, the large thick orbitohyoideus lies partly covering the lower part of the temporalis, and the posterior end of the adductor mandibulae posterior subexternus, the suspensorio-angularis, and the ceratohyo-angularis. (See fig. 2C, 2D.)

*Color:* Dorsally the general color of the tadpoles is a purplish lavender, which extends to the end of tail, although less dense

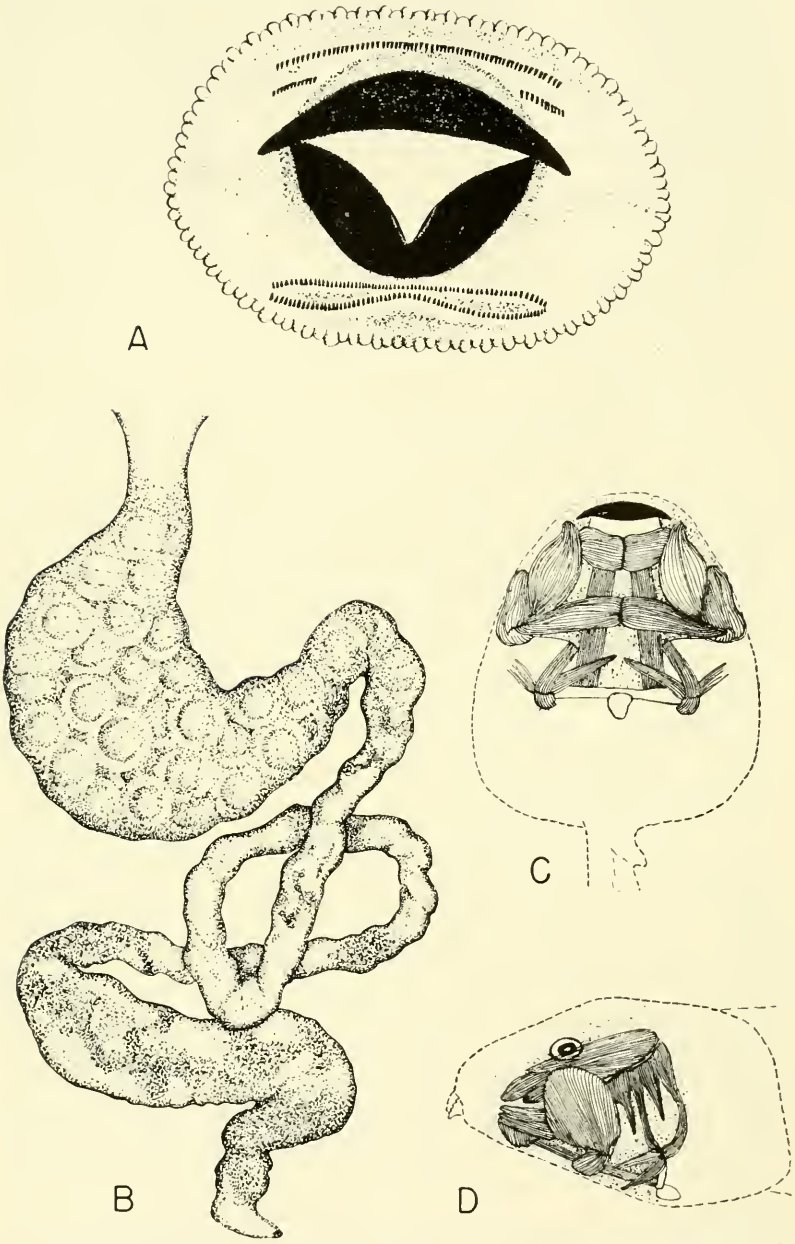


FIG. 2. Tadpole of *Anotheca coronata*. A. Mouthparts showing beak, and labial denticulations (lips stretched open). B. Stomach and intestine, displaced to show length. C. Musculature of the head, ventral view; D. Musculature of head, lateral view.

there. The young specimen had the color more lavender and of a lighter shade.

*Measurements in mm. of a tadpole of Anotheca coronata.*

| | |
|---|---|
| Length of body greatest | 11.6 |
| Greatest width of body | 10 |
| Greatest height of body | 6.6 |
| Eye from tip of snout | 3.1 |
| Distance between eyes | 2.8 |
| Eye to nostril | 1.7 |
| Nostril from tip of snout | 1.4 |
| Distance between nostrils | 2.4 |
| Diameter of eye | .5 |
| Total length | 27.5 |
| Tail length | 16.0 |
| Height of dorsal tail fin (greatest) | 2.05 |
| Height of ventral fin (greatest) | 1.95 |
| Spiracle, from level of snout | 6.8 |

*Remarks:* The lack of sufficient specimens from the southern part of the range of *Anotheca coronata* has made it impossible to evaluate the differences between the northern, Veracrucian, and the southern, Costa Rican, populations. There is seemingly a hiatus in the range of this species from the Meseta Central of Costa Rica to central Veracruz (region near Cordoba) a distance of approximately 1,100 miles. That discontinuity in range is an actuality in the intervening areas may be doubted but the fact remains that no specimens have been collected there. Careful collecting, however, may prove their presence.

The observable differences in my two Costa Rican specimens and those from Veracruz (all females) show the northern form with a troughlike depression on the snout between the strongly elevated canthi, while southern forms have the canthi scarcely elevated the top of the head and snout nearly flat. In northern forms the eyes are perceptibly larger and the circumorbital spines strongly elevated with a narrower interorbital region. The occipital region enclosed by spines is distinctly less in area. The hind legs are shorter, the tibiotarsal articulation reaching just in front of eye, while in the Costa Rican specimens it reaches to nostril or end of snout, and the fingers and toes are distinctly longer in specimens of equal snout-to-vent length. The color and markings are as follows:

In life the specimens from Costa Rica were purplish black with gray above; the dark leg-spots edged with cream, or on under sur-

face, with white; chin and throat with a conspicous brown area; lips and canthi edged with gray; venter and underside of limbs dark grayish lavender with a few white fleckings; palms and soles grayish black. In preservative they have become slate color above and below on abdomen. The limbs still show some lavender; the chin and throat are brownish.

Fig. 3. *Anotheca coronata* Stejneger K.U.M.N.H. No. 31860, Moravia de Chirripo, Limón Prov., Costa Rica. Actual snout-vent length, 62.5 mm.

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# Additions to the Known Herpetological Fauna of Costa Rica With Comments on Other Species. No. I.

BY

EDWARD H. TAYLOR

ABSTRACT: The paper treats of 19 species of Costa Rican amphibians. Five new species described are *Bolitoglossa alvaradoi, Bolitoglossa arborescandens, Oedipina alleni, Hyla manisorum,* and *Hyla weyerae.* The species *Hyla richardi* Taylor (*non* Baird) is renamed *Hyla richardtaylori.*

The following are reported for the first time in Costa Rica: *Leptodactylus labialis, Leptodactylus bolivianus, Hyla rosenbergi, Hyla staufferi.* The species *Eleutherodactylus florulentus* known from a mutilated specimen is redescribed from a perfect specimen.

## INTRODUCTION

Since the summer of 1947 I have been engaged in a study of the herpetological faunas of the Central American country of Costa Rica. This study has been based largely on collections made by Richard Clark Taylor and myself during the summer of 1947, and on a collection made by me in the summer of 1951. From these collections several publications have resulted, dealing with the salamanders, frogs, toads, and cecilians.*

In 1952, thanks to the kindness of the University of Kansas Endowment Association, funds were made available for a continuance of the work in Costa Rica. I reached Costa Rica on June 5 and collecting began June 6. With Mr. John Baker of Turrialba, Costa Rica as an able assistant, intensive collecting was continued until September 19 of the same year. A total of more than 4,000 herpetological specimens was acquired representing approximately 280 species and subspecies.

* (1) Costa Rican frogs of the genera Centrolene and Centrolenella. (2) Two new Teiid lizards from Costa Rica. (3) New salamanders from Costa Rica. (4) Two new genera, and a new family of tropical American frogs. (5) A brief review of the snakes of Costa Rica. (6) The salamanders and caecilians of Costa Rica. (7) The frogs and toads of Costa Rica. (See bibliography for place and date of publications.)

The parts of the country visited included many localities in which I had collected previously, as well as several that were new. Some time was spent in the Province of Guanacaste on the drier western part of the country, and in the wet southern part of the Province of Puntarenas, a region with an annual precipitation reputedly in excess of any other part of Costa Rica. Here we found several species not taken in the previous collections, certain of which were new to the known fauna. During the summer we were successful in acquiring representatives of numerous species previously represented by a single type or at most very few specimens, and certain ones that are new species.

It is a matter of regret that it has not been possible to pursue collecting in the winter and spring months, since I feel sure that forms of amphibians that breed at other times than the summer may still be wanting in collections.

Greater effort was made to obtain representatives of lizards on the 1952 journey. A number of species of anoles and geckoes were taken, not previously represented in my collecting, as well as certain species of teiids and iguanids likewise not taken before.

A few species of snakes, not met with before were encountered or were added to the collections through the kindness of friends, or through the medium of exchanges.

The principal places visited were as follows:

1. Turrialba and its general surroundings in the lower eastern part of the Meseta Central.
2. Moravia (de Chirripo) on the eastern slope of the Talamanca Mountain Range.
3. Cariblanco, at an elevation of about 800 M., north of the east-west range of volcanoes.
4. Cinchona (formerly American Cinchona Plantation) on the southeastern drainage of Volcán Poás.
5. Volcán Barba.
6. Peninsula of Puntarenas and region about its base.
7. Western slope of the Meseta Central.
8. Tenorio, the great cattle ranch of the United Fruit Company on the southwestern slope of the Cordillera del Guanacaste, extending to the slopes of Volcán Tenorio.
9. Pan-American Highway from Cartago, in the Meseta Central, to San Isidro del General (715 M.) on the western slope of the Talamanca Range, crossing the Talamanca Range on Cerro de la Muerte at an elevation of 3,300 M.

10. Palmar. Banana country near the western coast in the southern part of the province of Puntarenas.

11. Golfito. Banana country on the Golfo Dulce, near the extreme southeastern part of Costa Rica, Province of Puntarenas.

12. Limón on the Atlantic Coast.

13. La Lola, eastern lowlands.

14. Guápiles and Los Diamantes in the eastern lowlands.

## ACKNOWLEDGMENTS

In 1951 and 1952, Dr. Ralph Allee the Director of the Inter-American Institute of Agriculture at Turrialba made me welcome at that Institution and permitted me to use it as a base for collecting in the country. In many ways he and the staff of the Institute furthered my efforts. In 1953 I was able to obtain the much appreciated assistance of Mr. John Baker, whose father is an official of the Institute. I found John a helper of more than ordinary interest and abilities, who ably shared with me all of the vicissitudes of mountain and jungle collecting.

Mr. John Reark, a student at the Institute and Dr. Leslie Holdridge of the Bureau of Agriculture likewise were of much assistance in 1951. I am under deep obligation to Sr. Guillermo Esteves for very numerous photographs in color of living specimens.

To Lic. Oldemar Chavarria Ch., Mr. John Reark, Dr. Leslie Holdridge, Sr. Marco Tulio Pacheco, Sr. Don Juvenal Valerio and his son Sr. Julio Valerio, Mr. Paul Allen, and Mrs. Albert Weyer, I offer my thanks for the gifts of numerous splendid specimens.

For extended hospitality I offer my sincere thanks to Sr. Don Fernando Alvarado-Chacón, Mr. and Mrs. John Stelzer of Tenorio, Mr. and Mrs. Paul Allen of Palmar, Mr. and Mrs. Eugene Manis of Los Diamantes, Sr. Alfredo Echandi and Sr. Alberto Echandi of Cariblanco, Sr. Don Rubén Torres Rojas of Cartago, Mrs. Greening, my official hostess at the Compania Bananera installation in Golfito, and Prof. Don José Bustamente of Cinchona.

I am greatly indebted to the officials of the United Fruit Company for permitting me to visit various parts of their plantations, for transportation, and for extended hospitality.

The following persons have contributed to the expedition in various ways: Mr. Heino Itter, specimens; Mr. Leon Smith, transportation; Mr. Donald Fiester, specimens; Sr. Luis Siller, specimens; Sr. Victor Múnoz, Sr. Alfonso Trejos of the Hospital San Juan de Dios, specimens; Mr. Curtis Good, specimens; Sr. Don Jorge Ulloa, Mr. M. L. Harshberger.

This paper treats of the following amphibians:


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## *Bolitoglossa arborescandens* sp. nov.

Figure 1

*Type:* K.U.M.N.H. No. 34925 ♂ ; collected Aug. 16, 1951, Moravia de Chirripo, Limón Province, Costa Rica, by Edward H. Taylor.

*Diagnosis:* A rather slender species with webbed feet and costal grooves deeply cut and directed diagonally backward (except those in axilla and groin); head relatively narrow, its width, in length from snout to end of vent (9 mm: 65 mm.) 7.2 times; head length (13 mm.) in same, 5 times; adpressed limbs separated by approximately 1.5 costal folds; tail about 87 percent of distance from snout to end of vent; olive green above with sparse, deep-black dots; black on ventral surfaces; (green disappearing in preservative).

*Description of type:* Snout sharply truncate, the nostrils less than their diameter from the anterior tip of snout; canthal area rounded, the loreal region slightly convex; eyes moderately elevated, the distance between (4 mm.) twice (or a little less than) width of the eyelid; a very indistinct wide groove runs from behind eye, curves down toward jaw angle, joining a transverse groove arising slightly above the junction and passes across the throat in a somewhat sinuous line; the nuchal groove arises on side of neck, curves back slightly and passes across the throat bordered by a fold; the epibranchial cartilage forms an elevated ridge passing above arm

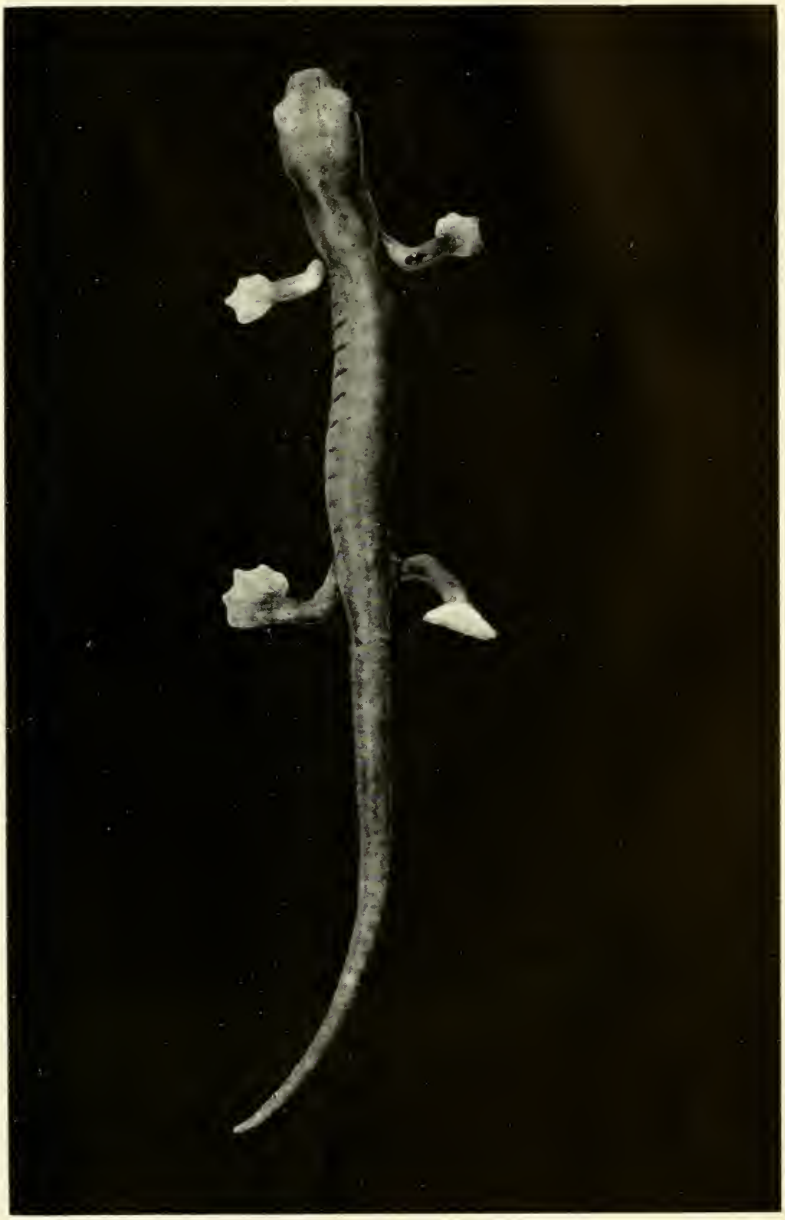

FIG. 1. *Bolitoglossa arborescandens* sp. nov. Type. K.U.M.N.H. No. 34925 ♂. Actual total length, 124 mm.

but not crossing completely the first costal fold; mental hedonic gland-cluster conspicuous, the individual glands gray white separated by dark reticulation; on front edge of lip below nostrils two pendant conical tubercles, their frontolateral faces bisected by the oronasal groove; a small diagonal skinfold behind angle of eye; length of eye equal to its distance from nostril; two large premaxillary teeth penetrate the lip (but apparently others now missing are normally present).

Maxillary teeth 38-38 (counting missing teeth); mandibular teeth 50-51; paravomerine teeth (90-90) in two groups with only a slight division between; tongue bolitoglossoid without any trace of a sublingual fold; choanae small.

Arm brought forward, the fingers do not reach the tip of lower lip; fingers webbed, the border slightly emarginate between digits; legs rather long, the toes completely webbed; the edge of web slightly emarginate between toes; the postfemoral glandular spot present but scarcely discernible; tail 86 percent of the snout-vent length, rather circular in cross section, slightly constricted at base; about 29 caudal folds can be discerned, the terminal part of tail seemingly undifferentiated, none or only a faint trace of a subcaudal groove; costal folds on body 12, with 13 costal grooves counting one each in axilla and groin; when limbs are adpressed they are separated by approximately one and one-half costal folds. Skin on head, under a lens, pitted distinctly; on tail, under a lens, one discerns a reticulum like a fine honeycomb, marking the individual glands, conspicuous on ventral and lateral sides of tail.

*Color in life:* Lively olive-green with a scattering of tiny black dots on head and body, the color extending down on sides; venter, lower part of sides, limbs, underside of head and neck, deep black. In preservative the green has disappeared and the entire dorsum is black. Under clear liquid, in strong light, the tiny black spots can still be discerned.

*Measurements in mm.:* Total length 124; snout to end of vent, 65; tail 59; snout to arm 19; axilla to groin 35; width of head 9; length of head 13; arm 15.2; hand 5.5; leg 16; foot 6.6.

*Remarks:* This specimen was taken from a bromelia in a large, recently felled forest tree. I am unable to suggest its closest relative. It occurs with at least two other species of the genus at Moravia de Chirripo—*Bolitoglossa alvaradoi* and *B. colonnea*. Another species *B. striatula* occurs at Turrialba, a region of like climate and elevation, and this also may occur at Moravia de Chirripo.

*Bolitoglossa lignicolor* (Peters)

*Spelerpes* (*Oedipus*) *lignicolor* Peters, Monatsb. K. Akad. Wiss. Berlin, 1873, p. 617 (type locality Chiriquí, Panamá); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 2, no. 12, Feb. 15, 1952, pp. 734-735.

Collections in 1951 and 1952 resulted in the discovery of only a single large specimen of this species at San Isidro del General (K.U.M.N.H. No. 34924).

This specimen agrees with the type description save that it is considerably larger, measuring 155 mm. in total length. The length, from snout to end of vent, being 77 mm., the tail 78 mm. The width of the head (11 mm.) is contained in distance between snout and end of vent, 7 times; the head length (14 mm.) into the same distance 5.5 times.

In the type the width of the head is contained some five times in this distance ("etwa fünfmal in der Entfernung der Schnauzenspitze von der Analöffnung enthalten."). It would appear that the head width does not increase proportionally with body length. The measurements of the type are included in parentheses with measurements of this specimen. Total length 155 (100); snout to end of vent 77 (49 +); tail 78 (48); snout to arm insertion 22 (17); axilla to groin 43.5 (29); arm 17 (12); hand 5.7 (4); leg 16 (13.5); foot 7.2 (5).

The color from snout to tip of tail is yellowish brown, flecked or marbled with darker pigment, which may unite to form somewhat larger flecks or indistinct short lines. The lower half of the sides are darker gray, the chin and venter having numerous cream or yellow, somewhat linear marks. The limbs are blackish, and the tail is mottled in dark gray, the cream marks showing a slight pinkish wash.

Peters does not give specific data on the dentition of his type. In my specimen the paravomerine teeth are in a single patch consisting of approximately 204 teeth; the maxillary teeth are 23-25; the mandibular 40-40; vomerine teeth 13-14 in two curving series rather widely separated mesially, each arranged in a single series beginning beyond outer level of choanae. Only three premaxillary teeth are present and these are larger than the maxillary teeth but are in the tooth line. There are 13 costal grooves more or less distinct, and 12 folds. The adpressed arms and legs are separated by 3½ folds. The feet are much broader than the hands. The interorbital space is about 2¼ times the width of an eyelid. The length of the eye is somewhat less than its distance from the nostril.

I have considered the possibility that *B. palustris* Taylor might be a young specimen of this species. However the characteristics—vomerine teeth forming an irregular patch on strongly elevated ridges (low in *lignicolor*), the domelike character of the palate (much less so in *lignicolor*), and the choanae of the type actually larger than those of this specimen of *lignicolor*, more than double its size, the tail compressed, higher than wide, the color different—all point to a distinct species. I think it most unlikely that these differences could be due to age.

*Bolitoglossa alvaradoi* * sp. nov.

Figure 2

*Type:* K.U.M.N.H. No. 30484 ♀; Collected at Moravia de Chirripo, Limón Province, Costa Rica, Aug. 16, 1951, by Edward H. Taylor.

*Paratypes:* K.U.M.N.H. Nos. 34903, 34904, June 26, 1952; No. 34905, June 25, 1952; all from Moravia de Chirripo; same collector.

*Diagnosis:* A rather large arboreal salamander, with 13 moderately distinct costal grooves, transverse rather than diagonal; the width of head, in the length, snout to end of vent (13 mm; 77 mm.) approximately six times; head length (15.6 mm.) in same length, approximately 4.9 times; adpressed limbs separated by approximately three costal folds; body black with blotches of pinkish fawn or cream, sometimes the color more or less generally distributed; limbs, front of head, and tail terminus black; tail equal or minutely less in length than distance from snout to end of vent. Foot and hand almost completely webbed.

*Description of type:* Snout truncate, the nostrils separated from the tip of the snout by a distance equal to diameter of nostril; snout flattened, the canthus not indicated, the loreal region not convex; eyes slightly elevated, the interorbital distance twice width of an eyelid; no distinct longitudinal groove behind eye; a transverse groove beginning somewhat above the level of the mouth passes over the back part of jaws and crosses the throat; a nuchal groove arising on the side of the neck passes across throat forming a groove bordered by a free flap one and one-half millimeters wide; the epibranchial cartilage forms a strong fold on the side of neck, passing above arm as far as the beginning of the second costal fold; female without mental hedonic gland (present in males); on lip a small swelling below the nostril with the oronasal groove bisecting

* Named for Don Fernando Alvarado Chacón owner of Moravia de Chirripo.

its frontolateral surface; a distinct diagonal skinfold behind angle of eye.

Eight tiny premaxillary teeth lying within the normal curve of the maxillary tooth row; maxillary teeth approximately 44-45; mandibular teeth 58-59; paravomerine teeth in two closely approximated

FIG. 2. *Bolitoglossa alvaradoi* sp. nov. Type. K.U.M.N.H. No. 30484 ♀. Actual total length, 152 mm.

groups (very narrowly separated by a toothless line), numbering approximately 146-142 in the two groups; vomerine teeth in two somewhat irregular elevated rows beginning outside of the choanal level, and curving in and backward, 15 on left side, 11 on right (beginning within the inner level of right choanae [abnormal]); tongue bolitoglossoid, without a sublingual flap.

Arm brought forward the fingers fail considerably to reach tip of lower lip; fingers almost completely webbed, the third longest with emarginations in outline between each two fingers; legs relatively large, toes completely webbed with emarginations in outline between each two toes; postfemoral gland present; tail almost as long as snout-to-vent measurement, constricted at base, slightly compressed laterally and higher than wide; a subcaudal groove more or less indicated; 33 caudal grooves; body with 13 costal grooves and 12 costal folds, counting a groove in axilla and groin; when limbs are adpressed they are separated by approximately three costal folds; under a lens, top of head distinctly pitted.

*Color in life:* Above with a blackish-brown ground-color, with rosy-clay or fawn markings covering most of dorsal surface of head, body and tail; chin and throat brownish black; lower part of sides, ventral surface of body and tail purplish black. In preservative the pinkish shade is lost; venter blackish brown; ventral side of tail bluish black.

*Measurements and data of Bolitoglossa alvaradoi sp. nov.*

| Number | 30484 | 34903 | 34905 | 34904 |
|---|---|---|---|---|
| Sex | ♀ Type | ♂ | ♂ | ♂ |
| Total length | 152 | 129 | .. | 106 |
| Snout to end of vent | 77 | 65 | 62.5 | 57 |
| Tail | 75 | 64 | .. | 49 |
| Snout to arm | 22.3 | 19 | 18 | 17 |
| Axilla to groin | 43 | 37 | 35 | 32 |
| Arm | 17 | 15 | 14.6 | 12 |
| Hand | 8 | 6 | 5.8 | 4.9 |
| Leg | 19 | 15 | 15 | 14 |
| Foot | 8 | 7 | 6 | 5 |
| Premaxillary teeth | 8 | 5 | 6 | 6 |
| Vomerine teeth | 11–15 | 15–13 | 14–11+ | 15–15 |
| Maxillary teeth | 44–45 | 44–44 | 33–37 | 36–41 |
| Mandibular teeth | 58–59 | 53–54 | 45–50 | 48–49 |
| Paravomerine teeth | 146–142 | 138–132 | 92–84 | 132–120 |

*Variation:* The notes on color of the various paratype specimens are as follows:

No. 6523. "Body reddish brown and black above forming island-

like areas; bronzy gray-black below; legs, back and under tail deep black." No. 6524. "Same as above"; No. 7040. "Dark red-brown with salmon flecking above on black ground color; blackish below; a very irregular median black line."

### *Chiropterotriton abscondens* Taylor

Figure 3 (left)

*Chiropterotriton abscondens* Taylor. Proc. Biol. Soc. Washington, vol. 61, Nov. 12, 1948, pp. 177-178 (type locality Isla Bonita, [American Cinchona Plantation] elev. 5,500 ft., Volcán Poás, Costa Rica); and Univ. Kansas Sci. Bull., vol. 34, pt. 2, no. 12, Feb. 15, 1952, pp. 702-704, text fig. 1.

By accident we discovered in 1952 the major habitat of this small form on the slopes of Volcán Poás. We had been searching for *Magnadigita subpalmatus* on the old road-cuts near Cinchona where in 1947 my son and I had collected a series of 43 specimens. Using the same technique at night that had been employed before, we found not a single specimen. We knew they must be there so in daylight we uprooted the thick beds of moss on these road-cut surfaces and shook them out on the road bed. A series of 20 specimens of *Chiropterotriton abscondens* was thus obtained, together with four other species of salamanders, none of which was *Magnadigita subpalmatus!*

The specimen figured is typical.

### *Oedipina alleni* * sp. nov.

Figure 3 (right)

*Type:* K.U.M.N.H. No. 34926 ♀. Collected at Palmar, Puntarenas Province, Costa Rica, Sept. 2, 1952 by Edward H. Taylor.

*Diagnosis:* A diminutive salamander, with 18 costal grooves and 17 costal folds; maxillary teeth reduced to 2 on each side; 2 premaxillaries; paravomerine teeth in a single patch of about 110 teeth; vomerine teeth 5-7; a few mandibular teeth, probably less than ten; choanae large, not widely separated; no longitudinal groove behind eye; arched lines or grooves on chin absent; adpressed limbs separated by about 7 costal folds; tail higher than wide. Head largely cream color; body variegated with cream and brown, becoming cream or fawn on tail; a dark stripe along side of head, body, and tail. Chin white, venter grayish.

*Description of type:* Snout oval in profile, the length distinctly greater than length of eye; top of snout curving transversely to lip;

* Named for Mr. Paul Allen my host at Palmar and my field companion when the species was discovered.

canthus rostralis not indicated; width of an eyelid a little more than half the interorbital distance; surface of occipital region smooth, without evidence of muscle outlines; a transverse groove behind eye crosses the jaws and passes across throat, curving slightly back mesially, but the lines or grooves normally arching forward on chin

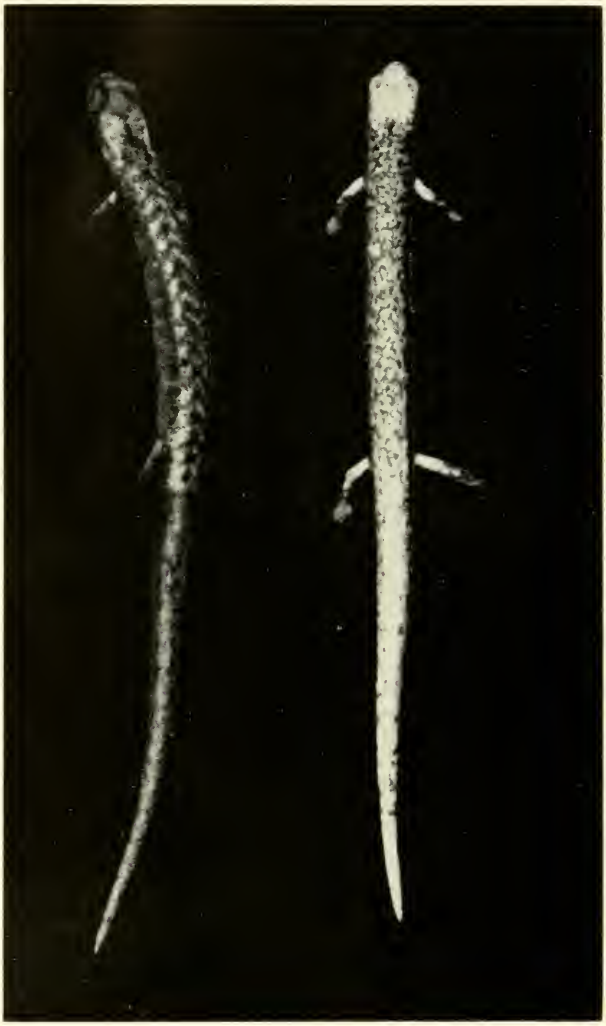

FIG. 3. Left. *Chiropterotriton abscondens* Topotype, K.U.M.N.H. No. 34935. Actual total length 71 mm. Right. *Oedipina alleni* sp. nov. Type, K.U.M.N.H. No. 34926♀. Actual total length 66 mm.

seemingly absent; nuchal groove begins near dorsal surface of body, passes down, curving forward, crosses neck in a convex curve bordered by a slight nuchal skinfold; snout rather strongly projecting beyond mouth; nostrils minute, the oronasal groove leaves nostril and runs down and back to a slight labial swelling on lip, distinctly posterior to level of the nostril. Tongue bolitoglossoid, not close to front of mouth, with a curving sublingual fold; vomerine teeth 5-7 on very low ridges, which curve back, the series not reaching outer level of choanae; latter large, separated by a space equal to 2½ times diameter of a choana; at least two teeth on maxillae opposite choanae; at least two premaxillary teeth; at least 5 mandibular teeth on each side; the palate posterior to the vomerine ridges, flat; paravomerine teeth separated widely from vomerine teeth; latter minute (probably less than half as large as in specimens of other species, having the same snout—vent length.)

Arm very short not reaching posterior angle of mouth; fingers four, nearly fully webbed, the third pointed with the tip free, the hand spread out flat; feet spread, the tips of the three middle fingers slightly projecting from web, the middle one with a rounded point; limbs adpressed, the digits separated by about 7 costal folds; 18 costal grooves counting one each in axilla and groin, and 17 costal folds, the last not strongly defined. Tail seemingly not constricted at base, but laterally compressed; about 28 caudal folds.

*Color:* Head cream-white on top, the eyelids bluish white; ground color of body cream, heavily speckled with brown, growing less dense and nearly cream on tail; a dark stripe from tip of snout along side of head and body to tip of tail; chin with a large cream area, the venter and under side of tail, with minute brownish reticulations which enclose cream dots; upper arm and leg lighter than lower part of limbs; postfemoral glandular area not, or very indistinctly visible; cloacal walls striate.

*Measurements in mm.:* Total length 66; snout to end of vent 34; tail 32; snout to foreleg 9; axilla to groin 21; head width 4; head length 5; arm 5.2; hand 1.5; leg 5.6; foot 2.1.

*Remarks:* The relation of this species is probably with *O. parvipes.* That form differs from this in having narrow pointed toes, the presence of 16-18 maxillary teeth, the submental grooves present and different color and markings. Dunn states that *parvipes* has a "sharp snout" and the tail is nearly twice head-body length.

## *Leptodactylus quadrivittatus* Cope

Figure 4

*Leptodactylus quadrivittatus* Cope, Proc. Amer. Philos. Soc., vol. 31, 1893, p. 339 (type locality, Buenos Aires, Costa Rica).

In my review of the Costa Rican frogs I had at hand no specimens of *Leptodactylus quadrivittatus.* In 1952 Mr. John Baker and I found the species occurring commonly in the southwestern part of Costa Rica in the region of heavy rainfall at Palmar and Golfito and considerable series were taken. Specimens were breeding at this time and numerous egg masses were found under trash (cut grass or matted growing weeds in swampy areas) or under logs or rocks in wet meadows.

The eggs, mixed in masses of foam, were in small excavations in the earth. The eggs, lacking all trace of dark pigment, were yellowish cream (sometimes an orange cream) the foam itself likewise being creamy in color.

The following numbers are in the collection. From Palmar Nos. 32317-32331; Golfito, 32332-32375. These specimens are in two different forms which may be readily separated by pattern and color; a median fawn or light brown stripe being present in one form. Those bearing the stripe from Palmar are Nos. 32317, 18, 22, 23, 26, 28, 29, 30, 31; those lacking the stripe are 32319, 20, 21, 24, 25, 27. From Golfito Nos. 32332-32359 are striped; Nos. 32360-32375 lack the stripe. Males and females are approximately equal in the series, and about equally divided in the two forms.

The type from Buenos Aires, Costa Rica is of the lined type, and our specimens agree with the description save that there are four longitudinal ridges instead of two on the dorsum. Although Cope states, "Two stout glandular ridges on each side of the vertebral median line," no dorsolateral lines are mentioned. However, he contrasts the species with Boulenger's *longirostris* and mentions as a difference "and there are but two dorsal glandular folds." *i. e.,* in *longirostris,* thus suggesting that there were more in the type of *quadrivittatus,* since a pair in the middle of the back, a dorsolateral pair, and a third pair low on the sides are present.

The form lacking the stripe has the interorbital area narrower than the upper eyelid; the dorsolateral ridges arising and terminating almost exactly as in the striped form, but on the dorsum just back of the eyes there are two indistinct, somewhat elongate tubercles, and in the shoulder region an elevated inverted Y-shaped ridge on the shoulders. Behind this, extending onto rump

are irregular low tubercles variable in size; on the sides there is a small glandular skinfold running diagonally to the groin continuous or nearly continuous with the supratympanic ridge; this ridge sends a branch behind tympanum to above arm. A hair-fine median ridge is evident in both forms.

FIG. 4. *Leptodactylus quadrivittatus* Cope. Upper. K.U. M.N.H. No. 32327, unstriped form, Palmar, Costa Rica. Actual snout-vent length 405 mm. Lower. K.U.M.N.H. No. 32373, Golfito, Costa Rica. Actual snout-vent length 49 mm.

Males of both forms may be distinguished readily by the folds of skin at the sides of the chin marking the vocal sacs, and their internal openings, which are ample and somewhat posterior in position.

The tongue is free along much of its sides, as well as behind, and the median notch is present. In males the edge of the snout is somewhat flattened, forming a slight shelf having a very slight downward flare It is rounded in females. The lateral skin-folds on the chin are usually pigmented with black. None of the specimens of the unstriped form show any trace of the four black stripes that run the length of the body nor the median fawn stripe. However within the limits of variation they have practically the same lateral head marks, supratympanic marks, similar black spots on front of thigh, on back of tibia, and a transverse white stripe bordered above by black on the posterior face of the thigh. The edge of the flap above vent has a tiny white mark. The characters of the feet, body proportions, ventral granulation of thigh, the ventral disc, and smoothness of the venter are characters common to both. These, taken with the fact that they were found together in the field as a single breeding population leaves the conclusion that only a single species is involved, and that the striped coloration and median dorsal skin folds are linked in inheritance, but they are not sex-linked.

The type described by Cope seems to have been a halfgrown specimen, since almost the entire breeding population exceeds the measurement of 37 mm. given by Cope for the type. I have measured a series of 14 striped specimens. Of these eight are females measuring between 48 and 51 mm. Six are males 45 to 48 mm. in length. Nine of the unstriped forms were also measured. Three females measure 47 to 51 mm.; 6 males measure from 44 to 48 mm.

It is probable that this species is related to *Leptodactylus poecilochilus* but the characters of the latter species seem to differ in a number of points. These are contrasted below, the data being from the type description.

"Color of superior surfaces chesnut brown, the sides rather darker, delicately marbled, next to the pure white abdomen."—The markings and color of both forms of *quadrivittatus* are different.

"Tympanum half the size of eye."—In *quadrivittatus* the tympanum is 3.5 mm. and the eye length 4.4 mm., thus much more than half eye length.

"Muzzle short not prominent"; the snout is 7.3 mm. long distinctly prominent, and not "short."

"Head rather depressed." The head definitely is not depressed.

"Vomerine teeth in two well-separated curved series behind the internal nares, the outer extremities of the former on a line with the middle of the latter." The vomerine teeth are in two elongate, slightly convex series closely approximated mesially and extending beyond outer (lateral) level of choanae.

"Heel extended reaches nostril." The tibiotarsal articulation extends beyond nostril.

"Toes not margined, slightly webbed at base;" I interpret the condition in *quadrivittatus* as without web.

The markings on the limbs are similar. However the difference in the size of the tympanum, the elongate muzzle, the character of the vomerine teeth, and the general difference in color would seem ample to differentiate the forms.

### *Leptodactylus labialis* Cope

Figure 5

*Cystignathus labialis* Cope, Proc. Amer. Philos. Soc., vol. 17, 1877, p. 90 (type locality "Probably a part of Sumichrast's Mexican collection" made chiefly in southeastern Mexico, Veracruz, Oaxaca, and Chiapas, restricted by Smith and Taylor to Potrero Viejo, Veracruz).

*Leptodactylus labialis* Brocchi, Étude des Batraciens de l'Amerique Centrale; Mission Scientifique au Mexique et dans l'Amerique Centrale, pt. 3, 2nd sec. (1881-1883), livraison 1, 1881, p. 20. (no specimens; data from type description.)

*Leptodactylus albilabris* Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, art. 10, June 20, 1918, pp. 323-325 (discussion of mainland and Antillean forms; reports the species in Nicaragua).

*Leptodactylus labialis* Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, pp. 403-421. (Fort Sherman and Majagual, Canal Zone.)

This species has a considerable range. In 1932 I reported the species in southern Texas, its northern limit of distribution. Dunn has reported the form in the Canal Zone on Barro Colorado Island. It has been argued that this form may have been introduced into Puerto Rico, and since Noble, *loc. cit.*, knew of no other Central American records than his Nicaraguan specimens it did not seem impossible that it may have been introduced there and in Panamá, and that the distribution of *labialis* was actually discontinuous. I did not include it in my review of the frogs of Costa Rica.

However, the discovery of this species on the coastal region of western Costa Rica suggests that the distribution is continuous and its apparent absence from other suitable Central American areas is due to faulty collecting.

FIG. 5. *Leptodactylus labialis* Cope. Upper. K.U.M.N.H. No. 34544. Actual snout-vent length 34.8 mm. Lower. No. 34543. Actual snout-vent length 35 mm. Both from Barranca, Puntarenas, Costa Rica.

The specimens, (K.U.M.N.H. Nos. 34543-34547), obtained by John Baker and myself the night of July 27, were hopping about on the rocky banks of a small rivulet in the general region of Barranca, Puntarenas Province, Costa Rica. Another series (K.U.M.N.H. Nos. 34548-34552) was taken by us at Tenorio, Las Cañas, Guanacaste, Costa Rica, August 21, 1951 in a small swampy area in pasture land, where springs kept standing water in hoof tracks on the closely cropped ground. These latter specimens were calling at night but there was no evidence that they were breeding at this time.

*Diagnosis:* A small leptodactilid, the females reaching a length of 38 mm., male, 32 mm. in Costa Rican specimens. Male without two horny spines on inner surface of first finger; a pair of vocal sacs indicated on chin by a pair of regular folds; first finger longer than second; a ventral "disc" present; an indistinct, more or less continuous, dorsolateral and a lateral fold or longitudinal series of glandular tubercles; tibiotarsal articulation to eye; males with a small shelflike extension of the sides and tip of snout. Length of tympanum about three fourths of the length of eye; dorsally brownish gray with black spots, flecks, or indefinite lines; below white.

*Description of species:* (From K.U.M.N.H. No. 34543). Body rather flat, the head also depressed, the eyes small, moderately prominent, canthi absent, the canthal areas rounded; the lores sloping, slightly concave between nostril and eye; nostril a little closer to eye than to median point on upper lip; length of eye (4.2 mm.) greater than distance between eye and nostril; distance between nostrils (3 mm.) a little greater than interorbital width (2.8 mm.); tympanum a little longer than high, its greatest diameter (3.1 mm.) less than eye length (4.2 mm.); distance between tympanum and eye slightly more than half greatest diameter of eye; a well-defined supratympanic fold runs straight back from eye, then bends down behind tympanum and continues to arm, while an enlarged glandular tubercle, running back from tympanum to arm, is separated from it by a groove; a glandular area outlined behind the tympanum (better developed in male than female); the vocal sac is evident as a well-defined skinfold on each side of the chin and throat.

Tongue subcircular, unemarginate behind, the posterior fourth or fifth free; choanae small, widely separated, rounded, the diameter of one contained in the distance between them about five times; vomerine teeth in two curving transverse elevated series, the elevations narrowly separated mesially and lying much behind posterior level of choanae; arm short, brought forward the wrist

fails to reach the tip of the snout; no digital webs, but some of the fingers with lateral ridges; first finger longer than second; second and fourth about same length; distal subarticular tubercles small or obsolete, proximal tubercles large on three inner fingers; four supernumerary tubercles on palm; a strong elongate flattened inner metacarpal tubercle, and an equally large, or larger, palmar tubercle; (male without trace of spines on first finger); toes lacking digital webs or fringes; practically no trace of lateral ridges on digits except near tips; subarticular tubercles strong except distal ones which are obsolete; sole and under surface of tarsus with numerous granular tubercles; a small inner metatarsal tubercle and a smaller distinct outer tubercle; inner tarsal fold indicated by a continuous row of white tubercles; no outer fold.

Skin of head nearly smooth; on back and sides finely corrugated with a nearly continuous dorsolateral skin fold or ridge; sides with irregular tuberculation with one conspicuous row tending to form a longitudinal fold midway on side. A shield-shaped "disc" distinctly outlined on venter; chin, venter, and under arms glassy smooth; the median and posterior thigh region granular, the granules extending somewhat onto the posterior surface of thigh and below vent; a few pearly tubercles on the tibia; tibiotarsal articulation reaches to the eye.

*Color:* Above brownish gray, the tip of snout lighter gray; a pair of black lines begin on tip of snout and extend to eye (partly broken); a dark line borders lower edge of the supratympanic fold; tympanum brownish, pigmented; a pair of blackish blotches above eyes, more or less joining mesially, extend back narrowing posteriorly; a milk-white median spot just behind shoulders usually preceded or partly surrounded by a darker mark; legs banded with dark olive or brownish black; back of thigh flecked and spotted, with an indefinite, cream-colored, transverse line. Chin, venter, and underside of arms white; some darker flecks under thigh.

*Measurements in mm.:* Snout to vent, 35; head width, 12; head length, 12.7; arm, 17.2; leg, 52.3; tibia, 17; foot and tarsus, 27.

*Variation:* There is not much significant variation, except that due to sexual dimorphism, in the Costa Rican specimens. In life they vary somewhat in ventral coloration some being more or less yellowish or yellowish flesh on thighs. Certain specimens from Tenorio have a pinkish color on thighs. The blackish areas are often olive in life.

The genus *Leptodactylus* is in need of revision. The extraordinary modifications of the male first finger in certain species in the genus, strongly suggests that a generic split is warranted.

### *Leptodactylus bolivianus* Boulenger

Figure 6.

*Leptodactylus bolivianus* Boulenger, Ann. Mus. Genova, ser. 2, vol. 19, p. 131 (type locality Bolivia).

A series of specimens K.U.M.N.H. Nos. 32292-32304, collected at San Isidro del General, Palmar, and Golfito have been referred to this species, originally described from Bolivia. South American material available for comparison has been scanty and it may well be that subspecific differences obtain. As the species was unknown to me as a member of the Costa Rican fauna it did not appear in my "Review of the Frogs and Toads of Costa Rica." In consequence I present a description of the species.

*Diagnosis:* A large species attaining a size of 105 mm. (in Costa Rica my largest specimen, from San Isidro del General, measure 90 mm.), the habitus typically ranalike; a pair of dorsolateral glandular ridges with a lateral ridge running from eye distinct and more or less continuous; snout elongate rather pointed; males with a pair of short conical horny tubercles on inner surface of first finger; fingers and toes unwebbed the toes with very narrow lateral dermal fringes; a strong inner tarsal fold; arms of males greatly thickened; heel to front of eye; a strongly defined ventral disc.

*Description of species:* (K.U.M.N.H. No. 32292 ♀). Length of head (33 mm.) distinctly greater than width (29 mm.), oval in outline; eyes large, moderately elevated, its length (8 mm.) equal to its distance from nostril, less than length of snout (12 mm.), nostril much closer to median point on upper lip than to eye; interorbital width (5 mm.) distinctly less than width of an eyelid; snout sloping obliquely down in front of nostrils, extending beyond lip (2 mm.); canthus absent, the loreal region with a longitudinal depression. Tympanum longer than high (6 mm. x 5.4 mm.) the upper edge overhung by a strong fold from eye that continues to groin, separated from eye by a distance of 3.5 mm.; a longitudinal gland at jaw angle; tongue elongate (21 mm.), its width 15 mm., free behind for 7 mm., free on sides to a lesser extent; distance between choanae (7 mm.) a little more than three times diameter of a choana; palatal glands open into a sinuous groove near anterior part of palate, whose ends turn back on each side of palate toward

choanae; vomerine teeth on two strongly elevated bony prominences, the teeth on their posterior edges in an inverted V-shaped group closely approximated mesially, behind choanae reaching laterally beyond inner edge of choanae; arm brought forward the wrist fails to reach tip of snout; fingers unwebbed, the inner edges of the second and third fingers with ridges (covered with fine thorny spicules in males); subarticular tubercles large; a large inner metacarpal tubercle and a bifid outer metacarpal tubercle; first finger distinctly longer than second; (in male first finger with a short horny conical tubercle placed beside subarticular tubercle and an-

FIG. 6. *Leptodactylus bolivianus* Boulenger. K.U.M.N.H. No. 32293, Golifito, Costa Rica. Actual snout-vent length, 91 mm.

other on forward end of inner metacarpal tubercle); arm of male, at insertion, double diameter of female arm.

Legs folded at right angles, heels overlap about 2 mm.; tibiotarsal articulation to the front edge of eye; toes elongate, pointed, without basal web but with narrow lateral dermal fringes; subarticular tubercles rather small; a small inner and a very small outer metatarsal tubercle; a strongly defined tarsal fold.

Skin very minutely corrugated; a pair of complete dorsolateral folds; a diagonal fold from eye to groin, with a small branch running behind tympanum; a row of warty tubercles above and below this fold. Skin of sides indefinitely granular; upper surface of femur and tibia with fine tubercles sometimes forming rows or fine ridges; chin and venter smooth with a large disc on venter; posterior part of ventral surface of thighs finely granular or areolar as is the mesial region below vent.

*Color in life:* Generally dark olive-green, the arms of a lighter shade than body; a large brownish-black spot between eyes extending on to occiput; black stripes extend partly over or along side the dorsolateral glandular fold; back with an irregular series of black rounded spots; a black line on canthus; a black spot in front of tympanum; a line from eye above tympanum runs back and then down behind tympanum; some lateral black spots; a stripe on back of upper arm and one under forearm; femur and tibia with irregular darker transverse bars; under surface of tarsus and foot blackish; posterior surface of thigh indefinitely reticulated. Venter grayish white, the pigment very sparse; lower lip darker with small cream spots. Tympanum brown. (In males chin darker.)

*Measurements in mm.:* Snout to vent, 90; head width, 29; head length, 33; axilla to groin, 34; arm, 42; hand, 20; leg, 133; tibia, 43; foot and tarsus, 62.

*Variation:* Some of the males have only the posterior part of the lateral glandular fold. In males the arm above is very light green in life; and in preservative it is brownish gray. The upper surface of the hand is gray-white.

*Remarks:* The species behaves like, and has the same general appearance as *Rana pipiens;* they may be readily distinguished at a glance by the absence of webbing on the feet. I believe these specimens constitute the first Costa Rican record for the species.

Eggs are laid in masses of foam, large enough to fill more than a liter container. These masses are hidden under thick mats of grass

or weeds or under the edge of a fallen log in the immediate vicinity of water.

### *Eleutherodactylus florulentus* (Cope)

Figure 7

*Lithodytes florulentus* Cope, Proc. Amer. Philos. Soc., vol. 31, Nov. 17, 1893, pp. 336-337 (type locality, Boruca, Costa Rica.).
*Eleutherodactylus florulentus* Taylor, Univ. Kansas Sci. Bull., vol. 35, pt. 1, no. 5, July 1, 1952, pp. 765-766.

In 1952 I was successful in rediscovering this species known for the last fifty years from presumably only the single damaged type specimen. It belongs in the section of the genus to which *Eleutherodactylus rugosus* (Peters) belongs. It may be doubted that

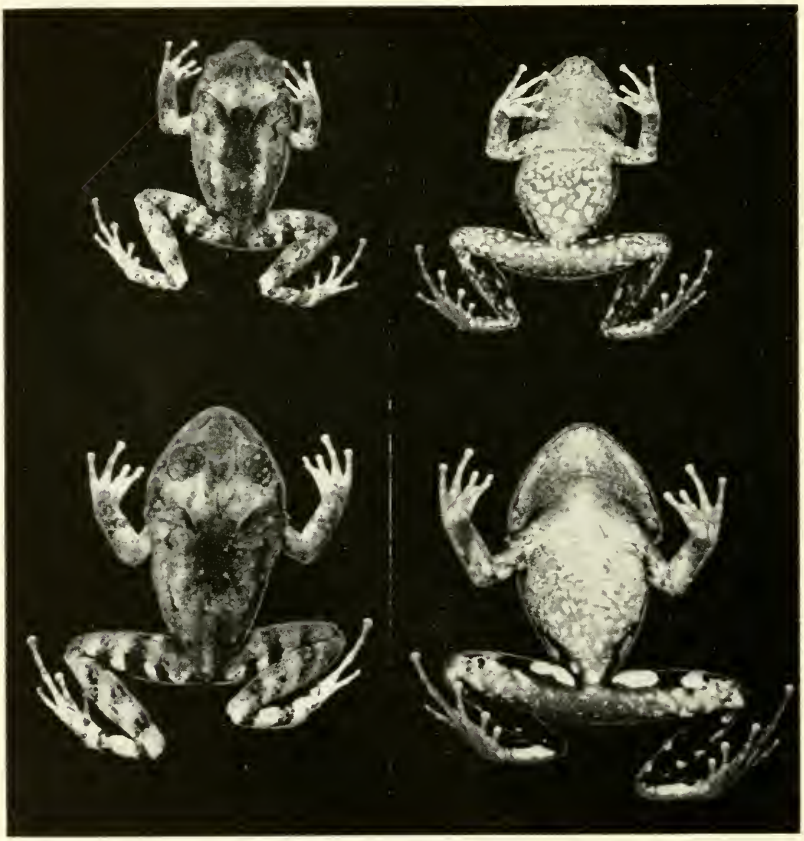

FIG. 7. *Eleutherodactylus florulentus* Cope. Upper. Dorsal and ventral views of K.U.M.N.H. No. 34908. Actual snout-vent length, 33 mm. Lower. Dorsal and ventral views of K.U.M.N.H. No. 34909. Actual snout-vent length, 44 mm.

it reaches a size comparable with that species. The type has the integument of the head destroyed and the typical cranial features have not been recorded. The largest specimen (K.U.M.N.H. 34909) of those taken, has the canthus rostralis very distinct, while the type description says it is not distinct. The description of this specimen follows:

*Description:* Head very broad, its width a little greater than its length, and equal to more than half length of body; snout oval in outline seen from above; canthus rostralis distinct, top of snout flat, roughened with tubercles; upper part of loreal region declivous then sloping obliquely to lip, leaving the region somewhat concave; eyes moderate, strongly elevated, width of an eyelid greater than interorbital width; a pair of bony ridges beginning in anterior interorbital region extend to back of occiput, separated by a shallow depression; eye length (6.1 mm.) greater than its distance from nostril (5 mm.) but almost equal to length of snout (6.2 mm.); tympanum large, distinct, its length 5.6 mm. separated from eye by a distance less than half its diameter; a strong tubercular fold from eye passes across upper edge of tympanum and curves down, not reaching its lower level. A pair of bony knobs behind eye on back edge of occiput. A strong pyramidal tubercle at lower posterior edge of tympanum; choanae rather small, largely lateral, separated from each other by a distance three times diameter of one; vomerine teeth in two thick fascicles well behind level of choanae, closely approximated mesially, not reaching inner level of choanae; palatal glands open into several pores between choanae at their anterior level. Tongue small, subcircular, notched behind, a small free edge borders posterior parts; openings of the vocal sacs small, short, back behind tongue near jaws; openings of Eustachian tubes small.

A pair of strong dermal ridges begin on the bony bosses behind eyes, and converge, stopping midway of back, but scattered tubercles following suggest a pattern that continues to pelvis; an irregular dorsolateral fold and on back above these are numerous warty tubercles or short ridges; sides warty or tubercular; venter smooth except as lateral granules encroach on sides; chin granular; much of surface under thighs, as well as a region behind vent, granular; hand free, the digits without lateral ridges, the tips widened with transverse terminal grooves; first finger longer than second; an inner metacarpal tubercle and a bifid palmar tubercle; foot with a trace of web, especially between the third and fourth toes; tips of toes with terminal discs, wider than those on fingers; a strong inner meta-

tarsal tubercle and a small but distinct outer; subarticular tubercles distinct; three supernumerary tubercles or swellings on hand, none on foot. Undersurface of hand, foot, and tarsus, glassy smooth; an indistinct inner tarsal fold; tibiotarsal articulation reaches beyond eye but does not reach nostril; when legs are folded at right angles to body heels do not touch; dorsal surface of tibia, femur, back and arms with scattered tubercles.

*Color in life:* Grayish brown to blackish brown with a lighter area on occiput between supratympanic folds. Arm gray brown with two indistinct darker bands. Leg brownish dorsally, the front and posterior face of femur dark black with the black and red-orange to scarlet interdigitating; in groin two large spots on femur and one on body yellow cream; on front face of thigh, bands of black (fading to brown) and pinkish fawn; a large triangular black spot involving vent and extending behind and below it; sole and under surface of digits and tarsus black; venter reticulated with darker and lighter; side of throat dusky. The figures show the details of the markings.

*Measurement in mm.:* K.U.M.N.H. Nos. 34909 ♂ and 34908 ♀. Snout to vent, 44, 33; head width 23, 16.7; head length 22.5, 15.6; axilla to groin 19.6, 15.2; arm 30.6, 20; hand 12, 10; leg from vent 73, 54; tibia 23, 17; foot and tarsus 31, 24.*

*Remarks:* Any discrepancies between the description of this specimen and the type description may be due to age and the mutilated condition of the type. The town of Boruca lies south of San Isidro del General in the lower drainage of the same river—the Río Diquis.

Specimens were obtained as follows: Nos. 34910-34919, Nos. 34920-34922, Las Esquinas; 34923, Golfito, localities in southern Puntarenas Province.

### *Hyla moraviaensis* Taylor

*Hyla moraviaensis* Taylor, Univ. Kansas Sci. Bull. vol. 35, pt. 1, no. 5, July 1, 1952, pp. 865-868, fig. 57. (Moravia [de Chirripo] Costa Rica.)

This small hyla was found to be common at the type locality in the period June 19-26, during which time a series of 40 specimens were taken. On Aug. 1, 1952 a single specimen was taken from a rivulet draining into the Reventazón across the river from the Inter-American Institute of Agriculture near Turrialba.

* Cope gives the length of foot 24. I suspect that the measurement of the foot of the type is incorrect. This is probably the length of foot and tarsus. Tarsus 9.

The largest female taken measures 44 mm. snout to vent, which is considerably larger than the type. The two largest male specimens reach a length of 32 mm. snout to vent, while most males are less than 30 mm. in length. The five largest females, all gravid, have the following measurements: 37, 39, 39, 40, 44. No eggs were being deposited, and only a single pair was found clasping, between June 19 and June 26.

### *Hyla staufferi* Cope

Figure 8

*Hyla staufferi* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 195, (type locality Orizaba, Veracruz).

This species has not heretofore been reported from Costa Rica although presumably it is known from Panamá. I obtained two

FIG. 8. *Hyla staufferi* Cope. Left. K.U.M.N.H. No. 32157 ♂. Actual snout-vent length, 25 mm. Right. K.U.M.N.H. No. 32158 ♀. Actual snout-vent length, 28 mm.

specimens, July 29, 1952, a male and female from under bark of a small tree growing at the edge of a pool at Maribella Hotel at the mouth of the Barranca River, western Costa Rica. These two specimens, herewith figured, are K.U.M.N.H. No. 32157, a male, and No. 32158, a gravid female. A third specimen, No. 32159 ♂, is from

Tenorio, Las Cañas, Guanacaste, Costa Rica, taken at night on a cactus stem, near a small swampy area. Whether this lowland species is present on the eastern coast of Costa Rica has not been determined.

### *Hyla richardtaylori* nov. nom.

Figure 9

*Hyla richardi* Taylor, Copeia 1948, no. 4, Dec. 31, pp. 233-234 (2 mi. west, Isla Bonita, Caribbean slope Volcán Poás, Costa Rica.)

This very striking species of *Hyla* described by me in 1948, was named *richardi* after Richard Clark Taylor who discovered the unique type. This summer in Harvard I came across the type specimen of *Hyla richardi* Baird, and learned for the first time that the name was preoccupied for *Hyla*, despite the fact that the name is listed in the synonymy of *Hyla versicolor* in Cope's Batrachia of North America, and is likewise given in the list of type specimens in Harvard. Boulenger has omitted the name in his catalogue. In

FIG. 9. *Hyla richardtaylori* nov. nom. Type. Actual snout-vent length, 71 mm.

order to carry out my intention of naming the species for its discoverer, I propose the name *Hyla richardtaylori*.

No other specimen of this large *Hyla* has been discovered. I believe it to be confined to the high mountain forest areas of the northern part of Costa Rica.

### *Hyla alvaradoi* Taylor

*Hyla alvaradoi* Taylor, Univ. Kansas Sci. Bull., vol. 35, pt. I, no. 5, July 1, 1952, pp. 882-885, fig. 63 (type locality, Moravia [de Chirripo], Costa Rica.)

I collected two more topotypic specimens of *Hyla alvaradoi* at Moravia de Chirripo, within a few meters of the exact type locality. The specimens were calling at intervals from low shrubs along a rivulet at night.

The color of one in life, (K.U.M.N.H. No. 31864) was as follows: Head generally washed in bluish green, the top greenish; throat definitely bluish about vocal sac, the mental swelling yellowish. Back greenish yellow, with yellow lines on canthi extending to eye; a yellow line above vent; bluish on knees; a whitish or yellowish white area on abdomen; concealed parts of limbs indefinite flesh color with very slight pigmentation; under surface of fingers yellowish, under toes whitish flesh. This was captured on the night of June 20, 1952.

No. 31865. Bright yellow green above, canthal lines yellow becoming cream above eyes; eyes bronzy brown; throat and concealed parts of limbs bluish flesh; under both hands, feet and digits, canary to lemon yellow; two lateral areas, clear yellow; dorsal part of limbs flesh, slightly tinted lemon yellow; edge of anal arch cream. This was taken June 24, 1952.

After preservation the colors largely disappeared within 48 hours and the specimens now are cream white with some fine purplish dots scattered on head and back, thus resembling the type.

### *Hyla boulengeri* Cope

*Scytopsis boulengeri* Cope, U. S. Nat. Mus. Bull. No. 32, 1887, pp. 12-13 (type locality, Nicaragua).

The presence of this species in the Caribbean drainage of Costa Rica is confirmed by a specimen No. 24741 taken by me at Turrialba in 1947. Three specimens taken by me on the Dominical Road about 15 miles WSW of San Isidro del General, prove its presence also in the Pacific drainage. Compared with the Turrialba specimen, a number of small differences are evident in these three specimens from the west. In specimens of equal length the tibiotarsal

articulation extends to or slightly beyond the tip of the snout, the femora are longer, the digital pads are observably larger. When legs are folded at right angles the heels overlap a much smaller distance and the body is less slender with a broader head. To determine the extent to which these differences are constant, it will be necessary to examine larger series from both drainage systems. The measurements are compared on the following table:

*Measurements of Hyla boulengeri (in mm.)*

| Number K.U.M.N.H. | 24741 | 34106 | 34104 | 34105 |
|---|---|---|---|---|
| Sex | ♂ | ♂ | ♂ | ♂ |
| Snout to vent | 45 | 45 | 46.4 | 47 |
| Length of head | 16 | 17 | 18 | 18 |
| Width of head | 14.5 | 15.3 | 16 | 16 |
| Tympanun | 3 | 3 | 3 | 3.1 |
| Length of eye | 4.1 | 4.4 | 4.5 | 4.55 |
| Eye to median tip of snout | 7.7 | 9 | 8.9 | 9.1 |
| Eye to nostril | 5.85 | 6.25 | 6 | 6.4 |
| Interorbital distance | 4 | 6 | 5.2 | 5.1 |
| Arm | 23 | 24 | 28 | 28 |
| Hand | 12.3 | 14.1 | 14.3 | 14.4 |
| Width of terminal pad | 2 | 2.8 | 3 | 2.8 |
| Leg | 66 | 75 | 75 | 77 |
| Femur from vent | 19 | 22 | 23 | 23 |
| Tibia | 24 | 26 | 25.2 | 27 |
| Foot and tarsus | 30 | 32 | 32.1 | 33.3 |
| Heels overlap | 7 | 6.1 | 5.8 | 5 |

## *Hyla wellmanorum* Taylor

*Hyla wellmanorum* Taylor, Univ. Kansas Sc. Bull., vol. 35, pt. 1, no. 5, July 1, 1952. (Type locality, Bataan, Limon Province, Costa Rica.)

This species, heretofore known by the type series consisting of four specimens from Bataan and Los Diamantes, Limón Province, is represented in the 1952 collections by three more specimens from the following localities: K.U.M.N.H. No. 32169, La Lola, No. 32171, Tunnel Camp, near Peralta, and No. 32170, Los Diamantes, all from Limón Province, Costa Rica. All three of these specimens show the typical markings and color of the type.

## *Hyla rosenbergi* Boulenger

Figures 10, 10a

*Hyla rosenbergi* Boulenger, Proc. Zool. Soc. London, 1898, Feb. 15, p. 123, pl. 16 (type locality, Cachabé, western Ecuador); Nieden, Das Tierreich; Amphibia, Anura I. Subordo Aglossa und Phaneroglossa, Sectio I, Arcifera 1923, pp. 264-265 (translation of type description). Breeder, Nat Hist. (New York), vol. 25, no. 4, July-Aug. 1925, pp. 324-337 (Breeding habits) photographs; Bull. Amer. Mus. Nat. Hist., vol. 86, art. 8, Aug. 26, 1946, pp. 375-436, pp. 42-60, numerous figs.

This species came to my attention from a specimen taken from the window of an airplane at Golfito, Costa Rica, by Stuart Baker, August 12, 1952. It was presumed that the frog had been picked up by the plane as it taxied into position for a take-off.

A second specimen, a male was found near Palmar, Sept. 2, 1952 (across river in low mountains), by following a frog call. It was sitting at the edge of a tiny rain pool in a depression near a rivulet—a pool about 1½ feet across. A third specimen was found in a small pool in an open field close to Palmar by John Baker, Sept. 3.

On September 6, we moved south to Golfito, where on the previous day there had been a heavy rainfall. In an area by the edge of the airfield where the grass had been cleared for a golf course, we found *Hyla rosenbergi* in considerable numbers at night. Males were in small water-filled depressions from one-half to one and one-half feet wide; the females were usually hidden nearby in piles of cut grass. One or two pairs were clasping but neither on this or the subsequent nights, Sept. 7-11, did we find any eggs deposited.

As we approached the area calls ceased and the frogs slipped under the surface of the water; but the pools containing frogs were discerned easily since the water showed a very milky color from disturbed sediment, while the other pools contained only clear water.

This series, I believe, represents the northernmost collections of the species. Mr. Breeder has reported its presence in Darién, Panamá. No Costa Rican specimen was available to me when I prepared my review of the Costa Rican frogs.

*Diagnosis:* A large frog reaching a length (in female) of 97 mm., with a distinct prepollex, less conspicuous in female, more distinct in male and terminating in a sharp curved spine available for clasping (see Fig. 10a); male with an elongate lateral gland extending more than half of the length between axilla and groin; diameter of tympanum three fourths of the length of eye; length of eye much shorter than snout; outer fingers webbed for four fifths of their length; toes almost completely webbed; tibiotarsal joint extends much beyond snout; inner and outer tarsal folds nearly obsolete; digital pads large but less than tympanum in diameter; vomerine teeth forming angulate series between large, somewhat angular choanae.

*Description of species:* (From K.U.M.N.H. No. 31849 Golfito, Costa Rica, female.) Length of head (23.8 mm.) slightly less than width (25 mm.); top of head flat, the eyes elevated prominently;

canthi blunt, curving, rather closely approximated posterior to nostrils; top of snout widening above nostrils which are narrowed and nearly vertical; loreal region sloping broadly with a shallow depression; in front of nostrils the snout turns down leaving nostrils within two millimeters of front point of snout and much closer to median point on upper lip than to eye; narrowest interorbital distance (8 mm.) equals distance between eye and nostril; tympanum large,

FIG. 10. *Hyla rosenbergi* Boulenger. K.U.M.N.H. No. 31849, Golfito Puntarenas Province, Costa Rica. Actual snout-vent length, 75 mm.

very distinctly pigmented, its greatest diameter (5.4 mm.) much less than the length of eye (7.3 mm.); distance between tympanum and eye 2.2 mm.; width of upper eyelid about equal to interorbital width.

Choanae very large, angular anteriorly; vomerine teeth in two elevated, angular series close to inner edge of choanae, the elevations separated mesially by a distance not exceeding the diameter of two teeth, 17 or 18 teeth in each series; openings of the palatal

glands in a transverse groove, separated from front edge of palate by a distance half that between groove and anterior level of teeth; tongue broad, subcircular, entirely adherent on borders save a free edge behind, one seventh of its length; (males with elongated vocal slits extending well under back part of tongue); half of forearm extending beyond tip of snout; outer fingers connected with a web extending four fifths of length of digits; not more than one-fourth webbed between first two fingers; an elongate metacarpal tubercle at base of first finger; a large outer metacarpal tubercle partly divided; pollical remnant small (larger in males); distal subarticular tubercles single; some supernumerary granules on palm; leg long,

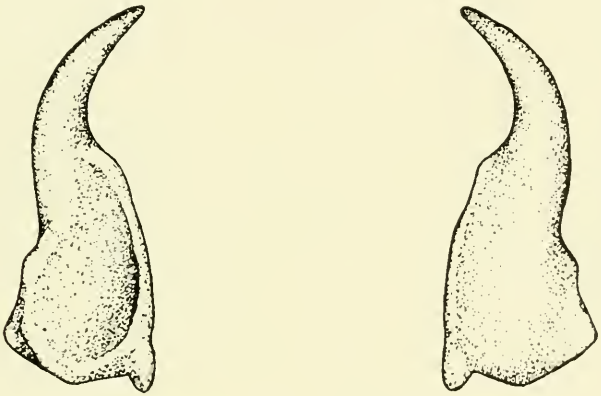

Fig. 10a. *Hyla rosenbergi* Boulenger. Pollical spine on male; dorsal and ventral views.

the tibiotarsal articulation reaching five millimeters beyond the tip of snout; toes almost fully webbed; a large flat inner metatarsal tubercle, no outer tubercle present; inner tarsal fold obsolete; outer fold not or scarcely indicated.

Skin above showing minute corrugations distinct under a lens; throat and chin indistinctly covered with minute granules; breast venter and under thighs with small nearly uniform granules, skin on front and back of thighs smoother; a few indistinct tubercles below vent, and a pair of indistinct ridges forming a vertical groove; a tubercular skinfold on posterior edge of forearm.

*Color:* Above brown with a median black line from tip of snout to rump; an indistinct black reticulation on back, sides and limbs with some black irregular darker markings; lines on sides somewhat vertical; immaculate white below; arms with small darker blotches,

legs with large spots, one on thigh, two on tibia; under part of digital webs dark; terminal pads light.

*Measurements of Hyla rosenbergii*

| Number | 31849 | 31847 | 31857 |
|---|---|---|---|
| Sex | ♀ | ♀ | ♂ |
| Snout to vent | 75.0 | 76.0 | 71 |
| Length of head | 23.8 | 23.5 | 24 |
| Width of head | 25.0 | 25.2 | 24 |
| Eye length | 7.3 | 7.1 | 7 |
| Eye to tip of snout | 11.0 | 11.4 | 11 |
| Interorbital width | 8.0 | 8 | 7 |
| Diameter of tympanum | 5.4 | 5.1 | 5 |
| Arm | 46.0 | 45.0 | 43 |
| Hand | 23.0 | 23 | 22.2 |
| Leg | 130.0 | 133.0 | 123.0 |
| Tibia | 43 | 46 | 41.5 |
| Foot and Tarsus | 56 | 58 | 51 |

*Variation:* Compared with the type description the Costa Rican specimens are very considerably smaller than the type (97 mm.). The fourteen males average 70.7 mm. in length ranging from 66-72 mm. (seven of fourteen specimens having a measurement of 72 mm.). The females, 7 in all, average 73.5 mm., and vary from 72-76. Thus the length of the type exceeds our largest specimen by 21 mm.

The specimens vary considerably in markings. Females are usually much lighter, some being fawn with little or no markings save a black median line; in others the reticulation is delicate and the darker spotting on the back and banding on legs is scarcely visible. The males are darker, usually gray-brown or blackish with lighter marbling, but in these the banding on limbs may be either distinct or indistinct.

The species seemingly is well established in Costa Rica and presumably has been so for a long period of time. Presumably its northward movement is limited to the southwestern area of very heavy rainfall. The elevation at which these specimens were taken is only a few meters above sea level.

## *Hyla manisorum* sp. nov.

Figure 11

*Type:* K.U.M.N.H. No. 34927 ♀. Collected at Bataan, Limón Province, Costa Rica, July 22, 1951; Edward H. Taylor, collector.

*Diagnosis:* A large frog (female 76 mm.), head skin free, a smooth back, toes a little more than one-third webbed; the terminal discs of

digits much smaller than tympanum which is two thirds to three fourths of eye. Canthus sharp; chin and breast smooth, granular on vent and posterior infrafemoral area; an inner tarsal fold; vomerine teeth in two distinctly triangular areas between large choanae, the teeth forming two rows converging anteriorly.

FIG. 11. *Hyla manisorum* sp. nov. Type. K.U.M.N.H. No. 34927 ♀ Bataan, Costa Rica. Actual snout-vent length 76 mm.

*Description of the type:* Profile of head seen directly from above a rounded oval, the length (25 mm.) less than its width at tympanum (29 mm.); canthus rostralis strongly defined, nearly straight, converging somewhat; area about nostrils somewhat elevated, with a slight depression between them; in lateral profile the snout sloping forward and curving back slightly so that nostrils almost reach

anterior level of lip, snout projecting beyond line of mouth about two millimeters; upper part of loreal region nearly vertical, lower part sloping rather abruptly to lip; whole loreal region somewhat concave; eye rather prominent its length (8 mm.) greater than its distance from nostril (6.3 mm.) but less than length of snout (9 mm.); tympanum large, distinct, subcircular, its diameter (6 mm.) equal to three fourths of eye length; tympanum separated from eye by a distance of 3.2 mm.; a distinct fold from eye curving above tympanum covering its upper edge and running down to jaw angle; a branch from it forms a small fold running back above arm (and may be continued farther); interorbital and much of occipital area with a shallow depression, the skull slightly elevated into two slight indistinct ridges beginning behind eyes and converging on back of skull. Width of an eyelid one and one-third times in interorbital distance.

Tongue subcircular, very slightly emarginate behind, not or but very slightly free behind and on sides; palatal glands opening through a series of slitlike pores; elevated triangular ridges supporting vomerine teeth reach anterior elevated rim of choanae (or nearly so), the teeth on their posterior edges form two diagonal converging lines separated mesially by a distance equal to distance from choanae; the inner rim of choanae (seen from below), is strongly depressed thus forming a depression between dental elevations and choanae. Openings of Eustachian tubes large, transversely widened, equal or of perhaps a little less than choanae in area.

Arm moderately long, nearly half of forearm reaching beyond mouth; no trace of a pollical spur or rudimentary pollex; web remnant between first and second fingers; other fingers between one-third and one-half webbed; discs rather well developed but distinctly smaller than tympanum; subarticular tubercles single; the inner metacarpal and palmar tubercles present, the latter however very ill defined; supernumerary tubercles not well defined; the row of tubercles under arm almost obsolete.

Leg rather short, tibiotarsal articulation reaching to front edge of eye; when legs are folded heels touch but do not overlap; when arm and leg are adpressed, knee and elbow are separated; toes nearly four-fifths webbed, discs only slightly smaller than those on fingers; a rather small inner metatarsal tubercle, the outer cannot be discerned and is probably absent; a well-defined inner tarsal fold beginning somewhat above tubercle, and reaching heel.

Skin smooth on head and dorsal parts of limbs and body; sides with a fine reticulation becoming more granular on venter; chin and

breast smooth; medial posterior part of under surface of thighs granular; vent with a very small flap, the opening on a vertical level with the posterior face of thighs.

*Color in life:* A rather dull brown above, grayish brown on sides becoming cream on ventral surfaces; posterior face of femur slightly darker with a faint suggestion of some lighter clouding or flecking; front of thigh and groin area brown with most indefinite cream flecks; tympanum more uniform, perhaps darker brown; on back several faintly browner flecks or spots; scattered pigment on under surface of foot, tibia, tarsus, and to a less extent, on the hand also.

*Measurements in mm.:* Snout to vent 76; width of head 29; length of head 25; length of snout 9; arm 45; hand 24; leg 121; tibia 40; tarsus 22; foot 33.4.

*Remarks:* This large specimen was found in a small rain pool during a heavy rain, at Bataan. In a nearby, but inaccessible tree, I heard an unrecognized, raucous frog call which I suspected might belong to this species. No others were heard while in Bataan.

I am uncertain as to the closest relative of this form.

The species is dedicated to my friends Mr. and Mrs. Eugene Manis of Los Diamentes, my hosts on numberous occasions, companions on collecting trips, and donors of numerous specimens to the collections.

*Hyla weyerae* sp. nov.

*Type:* K.U.M.N.H. No. 34850; from Esquinas Forest Reserve at Las Esquinas, between Palmar and Golfito, Puntarenas Province, Costa Rica. Oct. 1952, Mrs. Albert E. Weyer, collector.

*Diagnosis:* A small species with strong axillary webs, the webs attached on arm to near elbow; tibiotarsal articulation to slightly beyond tip of snout; outer fingers nearly one-half webbed; toes nearly completely webbed; femur pigmentless except for a few chromatophores near knee; a strong inner tarsal fold; subarticular tubercles on outer fingers double; chin and breast smooth, venter granular; vomerine tooth fascicles smaller than choanae. Color in life, bright yellow; in preservative reddish brown, the venter cream white with a large cream spot below eye.

*Description of type:* Head large, much wider than body; snout truncate, the canthal edge somewhat rounded but distinct; lores nearly vertical, sloping abruptly to lip, the region not or but slightly concave; area about nostrils not or but little swollen, no depression between; head a little wider than long; eye moderately elevated

extending out beyond jaw outline, its length (4 mm.) greater than length of snout (3.35 mm.); distance from eye to nostril 3 mm.; tympanum rather small (1.3 mm.), approximately one third of eye length; a fold from eye crosses its upper surface curving down considerably behind tympanum but scarcely reaching below the level of its middle; tympanum separated from eye by a distance greater than its diameter; a slight depression in frontal area; width of an eyelid in interorbital distance one and one-fifth times. Tongue (distorted) probably subcircular, not or scarcely free behind, and probably somewhat emarginate; a pair of small rounded ridges bearing very minute teeth lying between anterior halves of choanae, the groups less than half size of choanae, and separated from each other and the choanae by a distance equal to length of one ridge; openings of palatal glands in a groove much closer to choanal level than to front of palate; diameter of choana in distance between choanae approximately three times. Arm short, inner finger more or less opposed to other fingers, terminal discs much larger than tympanum; first two fingers one-fourth (or a little more) webbed; outer fingers nearly half webbed; the toes slightly fringed to discs; a fold on outer edge of fourth finger; inner metacarpal tubercle strong; palmar tubercle elongate but indistinct; no row of tubercles under arm; subarticular tubercles on two outer toes double; groove on edge of discs preceded by a free fringe, wider than is usually present in hylid frogs; leg long, tibiotarsal articulation reaching a little beyond tip of snout; legs, when folded at right angles, having heels overlap about eight millimeters; toes nearly completely webbed, the discs smaller than those on fingers but still larger than tympanum; inner metatarsal tubercle moderate, outer tubercle relatively very large; a distinct inner metatarsal fold.

Skin shiny smooth above; chin smooth, and without a fold on breast; venter covered with large granules; greater part of under surface of thigh granular; region below vent slightly granulate; a very strong axillary web which attaches along posterior face of arm to near elbow, and extends along side to near groin.

*Color:* In life "completely yellow" above; in preservation the dorsal surface is very light reddish brown rather distinctly separated from cream color of ventral surface of chin, breast, body and limbs; the brown color of limbs is confined to dorsal surfaces only; and on digits to outer finger and two outer toes; chin and lower lip completely cream; a large cream spot below eye but much longer than eye; front edge of upper lip brown; a darker brown stripe from eye, across tympanum and for some distance along side of body.

*Measurements in mm.:* Snout to vent 33; width of head 11.5; length of head 9.5; arm 21.2; hand 10; leg 60; tibia 20; tarsus 12; foot 17.

*Remarks:* This small species may belong in the group of small frogs that includes *Hyla alleei, Hyla rufiocula,* and *Hyla uranochroa,* but differs from all in the presence of the extensive webbing in the axilla and the greater length of the hind limb.

The species is dedicated to Mrs. Albert E. Weyer formerly of Golfito who discovered and preserved the type, and, together with other rare forms, presented it to the University of Kansas collections.

### *Rana palmipes* Spix

Figure 12

*Rana palmipes* Spix, Animalia nova, sivi species novae testudinum et ranarum quas in itinere per Brasiliam. . . . 1824, p. 5, pl. 5, fig. 1 (type locality Brasil).
*Rana palmipes hoffmanni* L. Müller, Mitteil. Zool. Mus. Berlin, Bd. 11, Heft 1. June, 1924 p. 80 (type locality, Costa Rica).

Lorenz Müller, in 1923, after a comparison of a Costa Rican specimen collected by Hoffmann, with the type specimen of Spix, in 1923 designated the Costa Rican form of *Rana palmipes* as a new subspecies, differing from the Brazilian typical form in having a slenderer body, smaller head, sharper and longer snout, smaller interorbital width, and a more strongly developed web between digits.

This species has had numerous subspecies proposed. Peters, who presumably had available the Spix type, named three species or subspecies—*Rana affinis* Caracas, Venezuela, *Rana gollmeri* Caracas, Venezuela, and *Rana clamata guianensis;* but later he placed the first two in synonymy of *Rana palmipes.* Cope described two new species *R. brevipalmata* (preoccupied and renamed *copii* by Boulenger) and *R. nigrilatus,* both from Nauta, Perú. Fowler named an Ecuadorean form, *R. brevipalmata rhoadsi,* Brocchi named a British Honduran form *Rana vallianti,* and Günther named *Rana bonaccana* from Bonaccana Island (off British Honduras) and *Rana melanosoma* from Duenas, Guatemala, and Nicaragua, 3,250 ft. elev. Boulenger in 1920 placed all of these forms listed, in the synonymy of *palmipes.* He is followed by Kellogg, 1927, who admits the possibility that some of these forms may warrant recognition. Both authors point out that most of the nominal species are based upon very young specimens.

The form described by Müller was not listed either by Kellogg or Boulenger. The characters pointed out may serve to distinguish

it from Amazonian specimens but whether it is distinguishable from species described from Nicaragua or Ecuador, is still to be proved.

The photograph here given is of a specimen K.U.M.N.H. No. 30466), 73 mm. in length.

FIG. 12. *Rana palmipes* Spix. K.U.M.N.H. No. 30466. Turrialba, Costa Rica. Actual snout-vent length 73 mm.

## ERRATA

Univ. Kansas Sci. Bull., vol. 35, pt. 1, no. 5, July 1, 1952. The Frogs and Toads of Costa Rica.

Page 601, line 24, for *head* read *neck;* p. 657, 1, 11, before *Costa Rica* insert *Bebedero;* p. 660, 1, 16 for *of* read *on;* p. 688, 1, 17 inclose *female* in parentheses; 1, 47, before *discs* insert *toe;* p. 777, 1, 23 for *Alejuela* read *Alajuela;* p. 798, 1, 20, for *on* read *or;* p. 913, 1, 36 for *1939* read *1839;* p. 922, 1, 36, for *as* read *are;* p. 923, 1, 3, for *Phyrnohyas* read *Phrynohyas.*

## BIBLIOGRAPHY

BOULENGER, GEORGE A.

1898. An account of the reptiles and batrachians collected by Mr. W. F. H. Rosenberg in western Ecuador. Proc. Zool. Soc. London, Feb. 15, 1898, pp. 107-126, pls. 10-18.

BREEDER, C. M., JR.

1925. In Darien jungles, experiences of a student of reptile and amphibian life in a little-known part of Panama. Nat. Hist., vol. 25, 1925, pp. 324-337.

1946. Amphibians and reptiles of the Rio Chucunaque drainage, Darien, Panama, with notes on their life histories and habits. Bull. Amer. Mus. Nat. Hist., vol. 86, 1946, pp. 381-435, pls. 42-60, text figs. 1-25.

BROCCHI, M.

1881-1883. Étude des batraciens de l'Amérique Centrale. Mission Scientifique an Mexique et dans l'Amérique Centrale, livr. 1-3, 1881-1883, pp. 1-122, pls. 1-21, and 17 bis, 18 bis, 20 bis.

COPE, EDWARD D.

1865. Third contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 1865, pp. 185-198.

1874. On some batrachia and nematognathi brought from the upper Amazon by Prof. Orton. Proc. Acad. Nat. Sci. Philadelphia, 1874, Sept., pp. 120-132.

1877. Tenth contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., vol. 17, Aug. 15, 1877, pp. 85-98.

1887. Catalogue of the batrachians and reptiles of Central America and Mexico. U. S. Mus. Bull. 32, 1887, pp. 1-99.

1893. Second addition to the knowledge of the batrachians and Reptilia of Costa Rica. Proc. Amer. Philos. Soc., vol. 31, 1893, Nov. 17, pp. 333-347.

FOWLER, H. W.

1913. Amphibians and reptiles from Ecuador, Venezuela, and Yucatan. Proc. Acad. Nat. Sci. Philadelphia, vol. 65, 1913, pp. 153-176, pls. 5-10.

GÜNTHER, ALBERT

1885-1902. Biologia Centralia-Americana. Reptilia and Batrachia. 1885-1902, pp. I-XX; 1-326, pls. 1-76.

KELLOGG, REMINGTON

1912. Mexican tailless amphibians in the United States National Museum. U. S. Nat. Mus. Bull. no. 160, 1912, pp. 1-224.

MÜLLER, LORENZ

1923. Ueber neue oder seltene Mittel-und südamerikanische Amphibien und Reptilien. Mitteil. Zool. Mus. Berlin, Bd. 11, Heft. 1, 1923, pp. 75-93.

NEIDEN, FRITZ

1923. Das Tierreich. Lief. 46. Anura I. 1923, pp. I-XXXII, 1-584, text figs. 1-380. Berlin and Leipzig, Walter de Gruyter and Co.

NOBLE, GLADWYN K.

1918. The amphibians collected by the American Museum Expedition to Nicaragua in 1916. Bull. Amer. Mus. Nat. Hist., vol. 38, art. 11, June 20, 1918, pp. 311-347, pls. 14-19.

PETERS, W.

1859. Eine neue Gattung und eine neue Art von Fröschen aus Caráccas vor. Monatsb. Akad. Wiss. Berlin, 1859, pp. 402-403.

1863. Ueber ein neue Schlangengattung *Styporhynchus* und verschiedene ander Amphibien des zoologischen museums. Monatsb. Akad. Wiss. Berlin, 1863, pp. 399-413, pls. 1-7 (1864).

1873. Ueber eine neue Schildkrötenart, *Cinosternon Effeldtii* und einige andere neue oder weniger bekannte Amphibien. Monatsb. Akad. Wiss. Berlin, 1873, pp. 603-618.

SPIX, JEAN B. VON

1824. Animalia nova, sive species novae testudinum et ranarum quas in itinere per Brasilliam annis 1817-1820 collegit et discripsit fasciculus. 1824, 4to, Monachii.

TAYLOR, EDWARD H.

1948a. New Costa Rican salamanders. Proc. Biol. Soc. Washington, vol. 61, Nov. 12, 1948, pp. 177-180.

1948b. Two new hylid frogs from Costa Rica. Copeia, 1948, no. 4, Dec. 31, pp. 233-237, text figs. 1, 2.

1949a. Two new Teiid lizards from Costa Rica. Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 5, Apr. 20, 1949, pp. 271-278, text figs. 1, 2.

1949b. New salamanders from Costa Rica. Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 12, Apr. 20, 1949, pp. 279-288.

1949c. Costa Rican frogs of the genera Centrolene and Centrolenella. Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 4, Apr. 20, 1949, pp. 257-270.

1951a. Two new genera and a new family of tropical frogs. Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, pp. 33-40.

1951b. A brief review of the snakes of Costa Rica. Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 3-188, pls. 1-23, text figs. 1-7.

1952a. The salamanders and caecileans of Costa Rica. Univ. Kansas Sci. Bull., vol. 34, pt. 2, no. 12, Feb. 15, 1952, pp. 695-791, pls. 76-88, text figs. 1-14.

1952b. A review of the frogs and toads of Costa Rica. Univ. Kansas Sci. Bull., vol. 35, pt. 1, no. 5, July 1, 1952, pp. 577-942, text figs. 1-69.

25-1542

## Kansas University Quarterly

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